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BRACKLEY
PROPERTY DEVELOPMENTS

64 Bed Care Home
Crookthorn Lane, Climping, Littlehampton
200422

Mechanical Services Performance Specification

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Section One (B)

Preliminaries, M&E Requirements

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1B-1 INTRODUCTION AND INTERPRETATION

The Mechanical and Electrical Contractors shall complete the installations as detailed within this specification and associated documentation i.e. drawings, reports etc., employing skilled personnel and Specialist Contractors as necessary to achieve the standards described.

1B-1-1 DEFINITIONS

Authority having jurisdiction (AHJ) - Refers to organization, office, or individual responsible for enforcing the requirements of legislation or standards, or for approving equipment, materials, an installation, or a procedure

Contract Administrator – Refers to a representative of the company administering the project as defined in the Contract preliminaries.

Building Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the building works as detailed herein.

Building Services Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the combined mechanical and electrical installation works as detailed herein.

Contractor – Where this term is used within the specification, it shall refer to the Contractor completing the Works detailed herein and shall refer equally to Mechanical Main Contractor or Building Sub-contractor or any of the other "contractor" terms defined within this clause.

Electrical Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the electrical installation works as detailed herein.

Engineer – Refers to a representative of Couch Perry Wilkes.

Fire Advisor –Refers to organization, office, or persons responsible for approving the fire safety design, equipment, materials, installation and procedures such as Authority Having Jurisdiction (AHJ), Fire Officer, Fire Brigade, Building Control, Fire Consultant etc.

Main Contractor (or Principal Contractor) – Where this term is used within the specification, it shall be taken as the Contractor with overall responsibility for the completion of the Works on behalf of the Employer.

Mechanical Contractor – Where this term is used within the specification, it shall be taken as the Contractor mainly responsible for completing the mechanical installation works as detailed herein.

Specialist – Refers to a specialist company employed by any of the above to complete a part of the Works on their behalf. The employing Contractor shall remain fully responsible for all works undertaken by the Specialist.

Note: None of the above terms imply a contractual relationship this will depend on the contract arrangements.

DEFINITIONS			
BESA	Building Engineering Service Association	CDP	Contractor's Design Portion
BREEAM	Building Research Establishment Environmental Assessment Method	CDM	Construction Design Management (Regulation)
BS	British Standard	CIBSE	Chartered Institution of Building Services Engineers
BS EN	British Standard European Norm	IET	Institution of Engineering and Technology
BS EN ISO	British Standard European Norm International Standard	NICEIC	National Inspection Council for Electrical Installation contracting
BSRIA	Building Services Research and Information Association	TN-S	Separate protective earth and neutral conductors
CCTV	Closed Circuit Television	TN-C-S	Combined Earth and Neutral conductor separate protective earth and neutral downstream

1B-1-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which further define the requirements for the works.

1B-1-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BSRIA BG 6 Design Framework for Building Services	Electricity at Work Regulations
BSRIA BG 28 Soft Landing BREEAM	F Gas Regulations
BSRIA BG 38 Soft landing Core Principles	Gas Safety Regulations
BSRIA BG 54 Soft Landing Framework,	Health and Safety at Work Act

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STANDARDS	
BSRIA BG 61 Soft landings and Government Soft landings	Health & Safety (Display Screen Equipment) Regulations
Building Regulations	Health and Safety Executive ACOP L8 and HSG 274
COSHH Regulations	IET Wiring Regulations (BS7671)
Clean Air Act	Insurance Company Requirements
Clean Air Strategy	Pressure Systems Safety Regulations
Construction (Design and Management) Regulations	Liquid Petroleum Regulations
Control of Asbestos Regulation	Local Authority Building Control (LABC)
Control of Pollution Act	London Building Act and / or Building (Inner London) Regulations where applicable.
Dangerous Substances and Explosive Atmosphere Regulations	National Joint Utilities Group Publications
Electricity Safety, Quality and Continuity Regulation	Water Supply Regulations
Requirements of the Environmental Health Officer (EHO), Fire Officer and Building Control Officer	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

1B-1-4 CURRENCY OF INDUSTRY STANDARDS

In general, all works shall be completed in accordance with the latest versions of the relevant standards that are applicable at the time of contract commencement.

These standards may be updated, or new standards issued, during the execution of the works and if so the Contractor shall:

1) Comply with all new or updated statutory requirements that come into force during the contract period. Where notice of a change to these is in place during the tender period then compliance is deemed to be included in the tender price.
2) Advise the Engineer of all other relevant new or updated standards when these become known.
3) Obtain confirmation, from the Engineer, as to whether the works shall comply with these new or updated standards with respect to:
   - Subsequent phases.
   - Variations.

1B-2 GENERAL REQUIREMENTS

This Section of the Specification identifies general requirements which are applicable to all services and all sections of this specification.

1B-2-1 CONTRACT CONDITIONS

The contract conditions shall be as detailed

- In the main contract preliminaries set out for the Contract conditions.

1B-2-2 PROJECT DESCRIPTION

The project involves the design, supply, installation, testing and commissioning of the Mechanical Services. Scheduled below is a brief list of the services - this list is not exhaustive and is provided to give a general understanding of the works only:

- ***Provision of incoming Statutory services i.e. Water and Electricity***
- ***LTHW heating system***
- ***Refrigeration systems***
- ***Mains cold water and domestic water systems***
- ***General ventilation systems***
- ***Air conditioning system***
- ***Fire Hydrant system***
- ***Domestic sprinkler system***
- ***Above ground drainage system***
- ***Automatic control/building management system***

Please refer to Main Contractor's specification for a full description of the overall works.

1B-2-3 PHASING OF THE PROJECT

The project shall be phased to ensure minimum disruption is caused on site.

Refer to Contract preliminaries for further details.

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1B-3 SITE VISIT

A site visit shall be undertaken during the tender period to obtain satisfactory knowledge of the following:

1) Local conditions
2) Nature and accessibility of the site
3) The nature and extent of the operations
4) The supply of and conditions affecting labour
5) Storage space for materials
6) Position of underground services and drains
7) Space available for the execution of the works generally
8) Site Permit schemes and any restrictive site practises
9) Access and site restrictions

The tenderer shall include for all costs necessary to take account of the above. Arrangements for the delivery of materials to site shall be such that no congestion occurs and shall include for all additional handling and transporting due to site conditions.

No additional cost/claim shall be considered due to the failure to undertake a visit site and obtain the necessary knowledge.

1B-4 CONTRACT INCLUSION

The specific contract details are laid out in the Contract preliminaries. The Mechanical and Electrical Contractors shall include for all items necessary for the due and proper completion of the works according to the true intent and meaning of the Tender documentation and this shall include, but not be limited to, all:

1) Materials
2) Labour
3) Carriage
4) Offloading and positioning
5) Tools
6) Minor items such as screws, fixings etc.
7) Items shown on Tender drawings but not detailed in specification
8) Items detailed in specification but not shown on Tender drawings

All materials shall be new unless otherwise specified and of a type and rating matched to the duty for which they are intended. Samples of proposed fittings, materials and workmanship, where required by the Engineer, shall be submitted without delay and in good time to suit the project programme. All systems shall be complete and operational unless otherwise specified.

All test requirements at manufacturer's works, as listed in relevant British Standards or elsewhere in this specification, shall be met prior to dispatch of equipment.

All items of plant and equipment shall arrive on Site in good condition and be suitably protected from all hazards once there and all prime movers etc. shall be in working order. If items of plant are found not to function correctly after installation and this causes a delay to the Contract, the Mechanical and/or Electrical Contractor shall be charged for any costs incurred.

Care shall be taken to maintain services to areas that need to remain operational during the works. The Mechanical and/or Electrical Contractors shall not disconnect any services until they have established, in writing and through survey, the extent of these areas, and agreed an exact timing and methodology for the necessary isolation and diversion of services.

Where a client/site permit to work scheme (or similar) exists this shall be complied with in full together with necessary notice periods etc.

Should any of the tender information be found to be incompatible or ambiguous with other information, then this shall be raised as a query during the tender period and if no response is provided prior to the tender return date, the tender return shall include for the most onerous option available.

1B-5 SPECIFIED EQUIPMENT

Where materials are specified in this document they shall be included in the tender without adjustment or alteration. The Engineer may consider alternatives (as a below line tender sum option), at their discretion. Any alternatives must be provided with all supporting information to prove that it is at least equivalent to the specified product particularly regarding the following:

1) Performance
2) Physical size
3) Appearance
4) Longevity (robustness)
5) Energy efficiency
6) Certification
7) Product support and Warranty.

Where the specified product satisfies the criteria for enhanced capital allowances and hence is published within the energy technology product list, the alternative product must do likewise.

1B-6 PRE-TENDER ENQUIRIES

Prior to issue of this tender package, enquiries to the marketplace may have been undertaken by Couch Perry Wilkes to obtain quotations from suppliers, manufacturers and specialist installers etc. These may have been requested at varying times through

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the design development and therefore may not reflect the final design requirements of the project as tendered and may be out of date.

The Contractor shall not rely on the accuracy of pre-tender quotations and shall be responsible for obtaining new quotations based on the final design information contained within the tender specification, drawings, schedules and accompanying tender documentation. Where the specification package is issued as Performance information only, the Contractor shall obtain new quotations based on their final design requirements.

No additional cost/claims shall be considered due to the failure to obtain quotations against the final design information.

1B-7 SUPERVISION

Site supervision for the services work is required and shall be by a dedicated Services Site Manager or equivalent permanently based on site throughout the project.

It may be acceptable for a working Charge hand or Foreman to provide this service, but only with prior permission/acceptance by the client.

The supervisor shall be:

1) Present on site whenever work is in progress by or on behalf of the Mechanical or Electrical Contractor.
2) Appropriately qualified and have previous experience for the class of work specified.
3) Approved by the Engineer
4) A responsible representative to whom site working instructions shall be transmitted.

The site supervisor may be changed only after permission to do so has been granted by the Engineer and in exceptional circumstances only.

1B-8 ELECTRICAL SUPPLY

The characteristics of the available electric supply have been determined as follows:

1) Voltage – 400/230 volts
2) Frequency – 50Hz
3) Fault level – TBC by supply authority or measured by Contractor.
4) Earthing arrangements – TN-S or TN-C-S (PME)

The above shall be assumed for Tender purposes only - actual supply details shall be verified on site prior to commencing working drawings / placing orders.

All equipment, including motors and starters shall be provided to suit the voltages and phases as detailed in the particular clauses and shall be verified before final orders for materials are placed.

As part of their co-ordination duties, the Electrical and Mechanical Contractors shall exchange relevant information from their specifications that relate to equipment being procured prior to placing any orders. Thus, for instance, the plant control panels procured by the Mechanical Contractor shall accommodate the incoming cables being procured by the Electrical Contractor.

1B-9 WATER AND ELECTRICITY

Water and electricity consumed during the construction of the works shall be chargeable. For details of any variance refer to Main Contract.

1B-10 DESIGN RESPONSIBILITIES

1B-10-1 CONTRACTOR DESIGN

The Contractor shall assume full design responsibility for ALL of the works associated with this contract and as detailed herein. Design parameters, processes and methodologies are given in Section 6.

A number of schematic details and layouts have been provided - these demonstrate the design intent only. These drawings shall be developed both during the tender period to inform and complete the tender return and during the detailed design stage to provide a completed design. The completed design shall be fully compliant with this Performance Specification including relevant design guides, stated quality standards and performance criteria.

Include at tender for the contractual requirements including:

1) Design, installation and commissioning to achieve specified requirements.
2) Attending all meetings necessary to provide full detailed design and co-ordination of the services with all other trades.
3) Obtaining from the Main Contractor, during the tender period, the latest room data sheets for the design and costing processes to ensure that the tender submission is fully compliant with the latest information available.
4) Full co-ordination with the fabric of the building, user ergonomic requirements, structure of the building, existing trees, landscaping etc. and co-ordinating the installation with other trades. Where services routes or similar are shown on the drawings, these are indicative routes only.
5) Assessing at tender all plant room sizes, riser sizes, ceiling and floor void depths and service routes ensuring that the Architect and Main Contractor are fully aware of their requirements and accommodate them. All voids, risers and service routes shall offer suitable access in compliance with current CDM requirements and are suitably sized for periodic maintenance to be successfully performed.

1B-11 DESIGN SUBMISSIONS

The Contractor shall provide design submissions for all systems and equipment for which they have design responsibility. This shall include, where relevant to the system, the following:

1) Detailed design philosophy statements along with any assumptions made.

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2) Detailed calculations to determine size of plant/equipment/distribution, etc.
3) Audibility calculations e.g. fire alarm sounders
4) Visibility calculations e.g. fire alarm beacons
5) Calculations for the category of the lightning protection and surge suppression system.
6) Detailed and complete schematic drawings.
7) Detailed design layout drawings.
8) Detailed distribution systems design drawings to include design values, e.g. peak loading, fault levels, fire stopping, flow rate, velocity, resistance and reference for each section/leg.
9) Detailed schedules of all equipment with duties, sizes, redundancy and any other pertinent information.
10) Commissioning engineer's report on commissionability of the concepts and solutions proposed.
11) Full co-ordinated and detailed Autodesk Revit model, using the latest Architectural and structure Revit models.
12) Detailed controls (BMS) descriptions in plain, clear and concise English.
13) The proprietary names of all significant products to be included in the Works but not covered by the above items.
14) Any other written or drawn information the Contractor considers necessary to submit to further explain their proposals.
15) Identification of any ambiguities, inconsistencies or errors found by the Contractor in the documents provided by the Employer and a statement of how these issues have been dealt with.
16) Identification of any items or work not included in the tender sum but which are necessary for the completion of the Project.
17) A schedule of all comments received along with details of agreed actions taken or clarification to resolve any issues raised. The schedule shall be a "live" document updated on a regular basis as the design develops and the commenting procedure progresses.

Any work that commences without the submission of the relevant calculations, schedules and drawings being submitted shall be deemed to have been undertaken at the Contractor's risk and any installations subsequently found to be non-compliant with the design parameters shall be rectified at the tendering Contractor's own expense with no detriment to the programme.

A statement shall be provided as to whether or not, in each case, products specified by proprietary name, (either stated as specifically required or specified as examples meeting the requirements) are included in the Contractor's Proposals and, if not, the alternative being offered. Any departure from design intent shall be highlighted to be easily identified.

1B-12 TECHNICAL SUBMISSIONS

In addition to the design submissions, the Contractor shall provide full detailed technical submissions to demonstrate that they have understood the requirements of the criteria outlined in the tender documents and have provided a fully compliant solution.

The Contractor shall provide Technical Submissions for all items as listed below:

1) The chosen equipment from the list of manufacturers identified within the specification
2) Where manufacturers provide working drawings (equipment or system)
3) Any alternative item offered that differs from that specified (manufacturer, material, range etc.)
4) Any bespoke manufactured equipment.
5) Equipment with project/user specific programming, labelling or controls

Each Technical Submission shall be complete with the following information:

- A completed schedule for each item to show capacity/ duty, efficiencies, redundancy and design parameters used for the selection. (Use schedules within the specific sections of this specification where given.)
- Clear identification of the component/equipment/system being submitted with catalogue information, e.g. number or reference or title.
- Specific data sheets for equipment which shall include maintenance and any commissioning requirements.
- Working drawings as appropriate.
- All relevant information required to evaluate the proposal.

1B-13 COORDINATION

The tender drawings show design intent. They are not construction or working drawings and therefore do not show all bends, tees, sets etc. that are necessary to locate services correctly to avoid clashes and ensure good maintenance access. The Contractor shall:

1) Include for all materials etc. as required to provide a complete, fully co-ordinated installation for their services.
2) Complete co-ordination in conjunction with the Main Contractor, the Electrical/Mechanical Contractor and the Contract Administrator, both individually and jointly.
3) Be responsible for co-ordination of their Sub-Contractors and/or Specialists' installation
4) Ensure that all services are co-ordinated with the building itself and any other services present and agree the sequence and timing of each element of the installation in a manner that maintains the agreed co-ordinated arrangements and programme.
5) Where services are exposed to view or of architectural merit, mark out on site the positions of all equipment and services routes, including trunking, conduit and pipework etc. prior to their fixing and agree the same with the Architect/Engineer/ Contract Administrator.
6) Review architect's room layouts and elevations where available to determine exact locations.

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7) Pay particular attention to ensure that accessories are positioned to suit door openings, fitted furniture, etc.

8) At all "pinch points", heavily serviced areas, congested service routes or corridors and as otherwise specified elsewhere in this specification, produce drawings/sketches/details/REVIT models allocating space for all mechanical and electrical services and demonstrate that crossover points etc. have been agreed in a manner that allows sufficient access to all maintainable items. These drawings/sketches/details shall be produced by the Mechanical Contractor who shall also lead the associated co-ordination process.

9) Produce co-ordinated Mechanical and Electrical ceiling drawings at 1:50 scale, based on Architect's ceiling layouts, showing all ceiling mounted mechanical and electrical equipment. All necessary mechanical information shall be provided by the Mechanical Contractor. The Electrical Contractor shall take the lead to produce these drawings.

10) Submit all drawings etc. following the requirements for working drawings detailed in this specification.

11) Liaise with the Contract Administrator and CDM Principal Designer with regard to the assessment and reduction of hazard and risk in accordance with the current CDM regulations.

12) Include for all necessary aspect ratio changes of ductwork where needed to achieve a fully co-ordinated layout or to allow the systems to fit within available voids / under structural steels. These shall be deemed to have been included within the Tender Sum.

13) Take particular care to obtain uniform and tidy arrangements of pumps, valves, switchgear, outlets and ceiling mounted equipment. The precise position of a piece of equipment shall normally be determined as follows: -

    a) Single items of equipment which are visually remote from other electrical or mechanical equipment shall be erected at the mounting heights stated in the Specification or shown on the drawings.

    b) Two or more items of equipment, whether electrical or mechanical or both, which are to be erected on the same wall or ceiling, or which will otherwise be visually close to each other, shall be arranged in a neat and symmetrical group. Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines and not the edges of equipment; for this purpose the stated mounting heights may, with the Contract Administrator's approval, be varied slightly.

14) Not install any services in an uncoordinated manner. Any services installed that have not been co-ordinated or as shown on the co-ordinated drawings shall be re-positioned at the Contractor's own expense as necessary.

Any disputes shall be referred to the Main Contractor, who has overall responsibility for co-ordinating the construction activities.

1B-14 BUILDER'S WORK

Allowances are included in the tender for the provision of builder's work for the works such as:

1) Formation of brick or concrete bases for engineering plant.

2) Formation/excavation of trenches.

3) Provision of anchor thrust blocks.

4) Formation of horizontal and vertical service ducts, covers and access panels as appropriate.

5) Cutting/forming of holes and chases, etc., and making good.

6) Cable tiles, marker tapes and cable markers, which shall be provided by the Contractor, shall be installed by the Building Contractor.

The Contractor shall provide

1) Detailed information to the Building Contractor for all builders work required for the Contract works based on working drawings produced by the Contractor and manufacturers' drawings, etc.

2) Dimensioned drawings showing the sizes and positions of all builders work requirements.

Where it is not practical to indicate on the drawing the positions of small (<100mm dia) holes and chases, they shall be marked out on site by the Contractor; this does not apply to holes through structural concrete or beams, which shall be shown on the drawings.

The Contractor shall be responsible for the preparation of builder's work details of all his Sub Contractors / specialists.

The above shall be provided in good time to enable provision to be made for the same during the construction process. The Contractor shall provide builder's work drawings that are:

1) Based upon the installation drawings.

2) Fully co-ordinated as detailed elsewhere in this specification.

3) Provided in electronic format and:

    a) The Contractor shall agree the number of paper copies to be issued for comment by the Engineer,, for tender purposes assume 3 (three).

    b) The Contractor shall agree the number of paper copies to be issued for construction, for tender purposes assume 6 (six).

1B-15 INSTALLATION (WORKING) DRAWINGS

The Tender drawings issued are provided to show primary routes, design intent, component order etc. They shall not be used as working or fabrication drawings. The Contractor shall develop the tender drawings in order to provide a complete set of co-ordinated working and fabrication drawings for the installation works. The drawings and installed systems shall:

1) Include all fittings etc. required to comply with this specification.

2) Be based upon measured site dimensions - under no circumstances shall scaled dimensions from drawings be accepted.

3) Include minimum spacing as specified.

4) Be fully co-ordinated as detailed elsewhere in this specification.

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5) Be provided to the following scales:

DESCRIPTION	SCALE
Plant rooms, external compounds and the like, risers, electrical switch rooms and cupboards and meter rooms	1:20
Internal wall elevations for positioning of outlets, components etc.	1:20
Site distribution, incoming services etc. 1:100 as long as sufficient detail can be shown	1:100
Site distribution where insufficient detail can be shown	1:50
Details of brackets, supports and any special fixings	1:10
Manufacturers detail drawings of items of equipment	1:20
Any drawing not listed above	1:50

1) Be provided in electronic format and:
   a) The Contractor shall agree the number of paper copies to be issued for comment with the Engineer - for tender purposes assume 3 (three).
   b) The Contractor shall agree the number of paper copies to be issued for construction with the Engineer - for tender purposes assume 6 (six).
   c) Manufacture / installation works shall not commence until the drawing has been returned without any outstanding comments from the engineer, all comments shall be addressed prior to final copy being issued for manufacture / installation.

1B-16 FURTHER DOCUMENTATION TO BE PROVIDED BY CONTRACTOR

In addition to those items discussed in the preceding clauses, the Contractor shall provide all required documentation detailed within this specification, which shall include the following:

1B-16-1 PROGRESS DRAWINGS

The Contractor shall keep on site, available for reference by the Contract Administrator or other authorised persons, a full set of installation drawings on which the contractor shall record the work as installed.

1B-16-2 RECORD DRAWINGS

The Contractor shall provide record drawings that are:

1) Based upon the installation drawings.
2) An accurate record of the actual installation including any deviations from the working drawings that have occurred on site.
3) Fully co-ordinated as detailed elsewhere in this specification.
4) Indicative of the layout identity, size and position of all services installed.
5) Provided in electronic format.

The Contractor shall agree the number of paper copies to be issued for comment with the engineer - for tender purposes assume 2 (two).

The Contractor shall provide one full set of record drawings for each maintenance manual to include:

1) Reduced A3 colour copy inserted unfolded in A3 clear plastic wallets, all drawings to be visible without removing from wallets.
2) Full size copy folded and inserted into clear plastic wallets.
3) USB drive containing electronic copy in formats described elsewhere in this specification.

1B-16-3 OPERATING AND MAINTENANCE MANUALS

The Contractor shall produce all information necessary for inclusion in the building Health and Safety file, referred to as Operating and Maintenance (O&M) manuals below.

Program for production of O&M manual.

1) 2 (two) hard copies of the manuals are required, to include record drawings as outlined elsewhere.
2) Manuals and record drawings shall be compiled during the contract and an initial draft copy shall be available for the first commissioning of the engineering services. (Minimum 21 days before contract completion.)
3) Practical completion shall not be given until final copies (without unresolved comments from the Engineer) are provided.
4) Allow a minimum of seven days for the Engineer to comment.
5) Incorporate all comments, re-issue for comment if substantial change required.
6) Prior to Practical Completion supply final copies.

The O&M manuals shall be presented as a complete and coordinated package and shall include:

1) Bound in covers capable of withstanding continual heavy use.
2) An Index.
3) Helpful telephone numbers.
4) Instructions for dealing with emergency conditions for each plant.

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5) All information to enable operational staff to comprehend fully the extent, purpose and method of operation of the plant(s) including a full description of operation.
6) Detailed schedules of all plant and equipment installed, including model numbers, serial numbers and capacities and with reference numbers which agree with the detailed labelling strategy agreed with the engineer.
7) Schedule of manufacturers' names, addresses and telephone numbers.
8) Detailed instructions on the starting up, running and shut-down of all systems
9) Description of operational routines, together with diagrams showing the functions of all controls.
10) Clearly set out schedules showing the extent and frequency for which maintenance is required, in detail, and how it should be carried out
11) Maintenance and lubrication schedules listed in order of frequency.
12) Information to facilitate the ordering of spares and replacements
13) Common fault finding measures and remedial actions.
14) Any precautionary measures necessary to prevent corrosion or freezing etc.
15) Care required of plant which is or may be subject to seasonal or occasional use
16) A final copy of the report(s) prepared during testing and commissioning, including all test certificates.
17) Maintenance instructions provided by the suppliers of equipment and/or plant to support (not replace) the maintenance information
18) A full set of Record or 'As Fixed' Drawings.
19) Circuit and Test charts for each distribution board.
20) NICIEC/IET Test and Completion Certificates
21) Emergency lighting test certificates and record sheets.
22) Fire alarm test certificates.
23) Valve charts referenced to coincide with the marking of valve labels etc. called for in this Specification.
24) The size, type and length of each LV cable (to the nearest metre) together with the measured earth fault loop impedance
25) Interconnections between items of equipment, including those provided by others and terminal numbering and cables core identification for all alarm and control circuits
26) Drawings that include the work of Sub-Contractors, e.g. laboratory / medical gases and ventilation ductwork etc.
27) Schematic diagrams of the application of automatic controls and instruments etc. including a "Description of Operation".
28) The location and depth of buried services including those installed by Gas, Water and Electricity Authorities etc.
29) Schedules and/or diagrammatic presentations to amplify the drawings where necessary for clarification.
30) Building Regulations Part L Log Book.
31) Pressure Regulations documentation.
32) Building users guide.

Each manual to contain a DVD or USB memory device to contain the following:

1) BIM (Revit version used at design) Record model
2) CAD drawings (Latest AutoCAD version) and PDF copies of all Record and 'As Fitted' drawings.
3) Microsoft Word (Latest version) and PDF of all of Mechanical and Electrical Contractors' written instructions.
4) PDF copies of all manufacturers O&M manuals (in separate directory, named and cross referenced to match O&M manual descriptions).
5) PDF Copies of all certificates, commissioning results, test certificates etc.
6) Electronic copy of control strategies as final commissioned state.
7) Electronic copies of models, Building Regulation Part L assessments and log book etc. where prepared by the Mechanical and Electrical Contractors.
8) Pressure Regulations documentation.

1B-16-4 BUILDING LOG BOOK

The Building Logbook shall be completed in accordance with Part L of the Building Regulations.

1) In contracts where the Electrical contractor is employed as the Main contractor the log book shall be complied and issued by the Electrical contractor.
2) In contracts where both Electrical and Mechanical contractors are employed, or where Mechanical contractor is employed as Main contractor, the log book shall be compiled and issued by the Mechanical Contractor

The relevant electrical or mechanical information shall be provided to the contractor compiling the Log book as follows:

1) Information to be provided by the Contractor compiling Logbook (Mechanical and/or Electrical Contractor)
    a) The location of relevant plant and equipment, including simplified schematic diagrams.
    b) The installed capacities (input power and output rating) of the services plant.
    c) A report confirming that the building services equipment has been satisfactorily commissioned.
    d) Simplified Operating and Maintenance instructions that include provisions enabling the specified performance of equipment to be sustained during operation (this may be cross-referenced to O&M manual documentation).
    e) The locations, identifications and descriptions, including instructions of use of all building energy supply meters and sub-meters.

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f) A statement regarding air tests and air permeability carried out on the building. (Information may be required from other parties, such as the Main Contractor or Architect).

g) A simple description of the operation and control strategies of the energy consuming services in the building. (Control Specialist to develop from Engineers statements included in Specification).

h) A statement regarding how energy performance of the building (or each separate tenancy in the building) can be calculated from the individual metered energy readings. (Control Specialist to develop from Engineers statements included in Specification).

i) A schedule of floor areas of each of the building zones categorised by environmental servicing type (e.g. air conditioned, naturally ventilated, etc.).

j) Microsoft Excel spreadsheets set up for this particular project to allow recording all meter readings and energy consumption.

2) Information provided by the Engineer or Mechanical Contractor where they are the designer:

a) A description of the whole building, its intended use and design philosophy and the intended purpose of the individual building services systems.

b) Final Part L model output report and energy certificate / display energy certificate as appropriate to the building.

The contractor compiling the information shall be responsible for providing the Building Logbook as part of the O&M documentation. The format of any necessary input to the above items shall be agreed with the contractor compiling the Building Logbook. It shall be the responsibility of either the Electrical or Mechanical Contractor to provide the information in the agreed format.

The contractor compiling the Building Logbook shall be responsible for obtaining the relevant information from the Engineer and other parties in a timely manner to allow the Building Logbook to be provided with the other O&M documentation for comment and final handover.

In the event of this clause not being complied with to the Engineer's satisfaction, the Engineer reserves the right to recommend to the Contract Administrator that the Certificate of Practical Completion to the contractor compiling the documentation be delayed until such time that these items are approved and/or commission independently a Specialist in this field to provide the information, and to deduct the Specialist's cost from the contractor's final account.

The contractor compiling the Building Logbook shall be responsible to ensure the sign off of this takes place prior to Practical Completion.

1B-17 FORMAT OF DOCUMENTATION TO BE PROVIDED BY CONTRACTOR

The Contractor shall include for all information issued to the client and design team to be provided in the following electronic formats:

REQUIRED FORMATS	
DESCRIPTION OF DOCUMENT	FORMAT REQUIRED FOR ISSUE
Drawings, to be issued in both of these formats concurrently:	AutoCAD, issued in .dwg format with any xrefs bound to the drawing. PDF, without any restrictions on printing, copying, searching etc. (applies to all PDF's described below.)
Document issue sheets, Technical submittals etc.	PDF
Request For Information (RFI)	Word or Excel Document to enable responses to be added to document.
Output from calculation, modelling or part L software. To be issued in both of these formats concurrently:	ZIP compressed file of calculation input files with all information necessary to allow others to run the same calculations. PDF of any output / summary reports with sufficient information to allow results to be viewed and commented on by all parties.
Manufacturer's instructions, certificates, warranties etc.	PDF, original from manufacturer where available, else colour scanned in version by Mechanical and Electrical Contractors
Commissioning Results	PDF generally until final versions agreed then issue in PDF and editable version such as Excel spread sheet.
Certificates etc.	Original signed copy, along with PDF of the same.
H&S O&M manual	Bound printed copies and electronic copy of the same.
Any information / document not already detailed above.	PDF, original from manufacturer / supplier where available, else colour scanned in version by Mechanical and Electrical Contractors
All format versions shall be the latest version generally available at time of issue.	

The above is in addition to the issue of official / hard copies as required by the contract documents.

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1B-18 CONTRACTOR SUBMISSION REVIEW PROCEDURE

All information submitted by the Contractor shall be subject to a review process, with the submission being graded as follows:

- Status A – Proceed with design/installation in accordance with the submission
- Status B – Proceed with the design/installation in accordance with the submission incorporating the comments provided in the process.
- Status C – Do not proceed. Re-submit for further evaluation.

Only works graded A or B shall be progressed. No certification or payment shall be given for works undertaken at Status C.

Any drawings or documents prepared by the Contractor shall be prepared in good time to allow for the inspection procedure outlined above and having due regard to site progress and deliveries of materials.

The time allowed for comment by the Contract Administrator / Engineer shall be at least 10 days, subject to an agreed information release schedule. This period shall be allowed for within the program for preparing the above documents.

The above process does not apply to final documentation produced for completion, e.g. as fitted drawings, Building Log book etc. In this case the information shall be updated as required until free of comments, after which the Contractor shall submit final versions in the agreed format.

1B-19 SITE CLEANLINESS

The Contractor shall allow for cleaning up and removal from site of any rubbish as it accumulates during the progress of the works, including that of his Sub-Contractors/specialists. On completion of work the Contractor shall clear up and remove from site all superfluous materials, clean down external faces of buildings affected by the works, scrub paving and floors, clean out gullies and gutters etc., clean glass inside and out, remove all spots, splashes and stains and leave the works and all parts of the premises affected by them clean and in good order to the entire satisfaction of the Contract Administrator.

The Contractor shall ensure that all rubbish, waste and offcuts etc. are cleared away in accordance with the Main Contractor's waste management plan.

1B-20 DAMAGE DUE TO FROST OR RAIN BEFORE PRACTICAL COMPLETION OF THE WORKS

The Contractor shall make good at his own expense damage caused by frost or rain ingress due to building fabric leaking or equipment being inadequately protected. It is the contractual responsibility of the construction team not to store or install services and equipment in a building that is not sufficiently weather proof or water tight to avoid this damage. Any damaged services and equipment shall be either replaced or repaired to the satisfaction of the contract administrator and all costs for the remedial works shall be borne by the contractor.

1B-21 ARTIFICIAL LIGHTING AND POWER

All artificial lighting and power required for the whole of the works including Mechanical or Electrical Contractor's works shall be the responsibility of the Main Contractor who shall arrange for temporary supplies as necessary, temporary metering and for payment of cost involved.

Temporary metered electrical supplies to Mechanical and Electrical Contractor's site accommodation for heating and lighting purposes shall be provided by the Main Contractor. Special electrical supplies for use by the Mechanical and/or Electrical Contractors, e.g. workshop facilities, shall be provided by the Mechanical or Electrical Contractors.

Mechanical and Electrical Contractors shall allow for picking up from the temporary services provided by the Main Contractor with temporary leads to service his own requirements and he is to allow for reimbursing the Main Contractor the cost of electricity used in the Mechanical and/or Electrical Contractor's site huts.

All temporary electric wiring is to be to the satisfaction of the Contract Administrator.

1B-22 WINTER WORKING - ARTIFICIAL LIGHTING

The Mechanical and/or Electrical Contractors shall at his own expense provide adequate artificial lighting to ensure that normal weekly working hours may be worked on site despite the loss of natural light.

1B-23 TEMPORARY WORKS

1B-23-1 PLANT, TOOLS AND SCAFFOLDING

Allow for providing everything necessary for the proper execution of the work, including all requisite vehicles, plant, scaffolding, gantries, chutes, stages, fans, ladders, trestles, tarpaulins, tools, rods, moulds, templates, levels, tackle and other implements required for expeditious carrying out of the work in proper sequence, together with the carriage and cartage thereof, maintenance, adapting, shifting and removal of same when no longer required.

The Contractor shall provide and remove on completion, temporary screen and tarpaulins required to give adequate protection against wind, weather and prevent the spreading of dirt, dust and rubbish.

1B-23-2 DELIVERY AND OFF-LOADING

The Contractor shall carry out and shall provide all the necessary equipment for the off-loading, site transport and hoisting to the required level of all materials and equipment supplied under this Contract.

1B-24 OVERTIME OR NIGHT WORK

Overtime and Night work shall only take place as detailed within the Contract Preliminaries.

Where applicable the Contractor shall provide and allow for any overtime as stated within the Specification. The Contract Administrator shall receive not less than 24 hours' notice specifying times and locations of the work to be done. Any concealed work executed during overtime for which notice has not been given may be required to be opened up for inspection and reinstated at the Contractor's expense.

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Should the Contract Administrator issue specific instructions, in writing, for overtime working other than that specified within the Tender Documentation, then the net difference between normal time and overtime rates shall be added in the final account; provided that accurate and detailed returns are submitted each week to the Contract Administrator.

1B-25 FIRE PRECAUTIONS

The Contractor shall take all reasonable precautions to avoid the outbreak of fire, particularly in work involving the use of naked flames. The Contractor shall set in place and rigorously enforce procedures to minimise the risk of an outbreak of fire, which shall address the following general issues as well as any site-specific issue:

1) Disposal of flammable materials
2) Accumulation of rubbish on site
3) Hot works procedures including:
   a) Use of fire resisting mats, to prevent scorching or fire.
   b) Provision of firefighting equipment during the work.
   c) Fire watch during and after hot works.
   d) Hot works to stop at least two hours before leaving site.
4) Obtaining and clearing any required work permit from the client and following any additional requirements in their safety procedures.
5) Fire escapes being maintained clear and usable at all times.
6) Safe storage of highly flammable materials and gas cylinders.

The above procedure shall be detailed in a method statement issued to all parties for comment, and any comments incorporated, prior to commencing works.

1B-26 TESTING AND COMMISSIONING OF ENGINEERING SERVICES

Detailed Requirements for testing and commissioned are laid out later in this specification. In general:

1) All testing shall be carried out as recommended by the current edition of the IET wiring regulations (BS7671), relevant British and European Standards and Codes of Practice and current legislation.
2) The Contractor shall draw up a detailed testing and commissioning programme indicating critical dates of external influences.
3) The Contractor shall allow for their Commissioning Engineers being in attendance whilst the Engineer verifies the results and ascertains that the various elements of each system are in full working order. A minimum period of 1 week per month of the contract period (Minimum 2 weeks) shall be allowed for this procedure.
4) The Contractor shall allow for his Commissioning Specialist to demonstrate to the Employer that the design intent of the systems has been achieved.

1B-27 SOAK TEST PERIOD

Upon completion of the setting to work and commissioning of the services the Contractor shall perform a soak test of the systems installed. The soak test shall:

1) Be included in the programme for the works.
2) Continue until seven continuous days of plant operation have occurred without fault or failure of any component / function.

   During the soak test period the Contractor shall:
   a) Monitor all functions (pressures/temperatures/starts per hour etc.) which shall be trend logged using the microprocessor controls equipment where installed.
   b) Monitor each type of space served by the plant and equipment using digital data recorders (supplied by the Mechanical or Electrical Contractor) to verify the performance.
   c) Carry out any specified heat load and noise performance surveys
   d) Download/convert all data to Excel spreadsheet format (disc and hard copy).
   e) Send all data and monitoring results to the Engineer for acceptance by both the Employer and the professional parties

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 included by the Contractor.

Any costs incurred as a result of or a consequence of having to restart the soak test shall be at the Contractor's expense.

A successful soak test as described shall be carried out prior to practical completion being granted by the Contract Administrator.

1B-28 USE OF BUILDING SERVICES

The Contractor is reminded that they are responsible for the permanent engineering installation provided as part of this Contract until such time as the Certificate of Practical Completion is issued.

These installations shall not be used either directly for, or in connection with carrying out Contract works without the written consent of the Contract Administrator and appropriate Contractors and Manufacturers.

Should any systems be used in this way, the following applies:

1) The Employer does not undertake that it will be available.
2) It shall not be used until the plant has been tested to the satisfaction of the Contract Administrator and Engineer.

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3) The Contractor shall take responsibility for operation, maintenance (and remedial work) and arrange supervision by and the indemnification of the appropriate Sub-Contractor and pay all costs arising including extending all associated warranties accordingly.

4) The Contractor shall effect any additional insurances required and pay all additional costs associated.

5) The Contractor shall pay costs of fuel or water used.

6) The Defects Liability Period shall commence from the date of Practical Completion of the works, and not from the date when parts of the installation(s) are brought into use for the above reasons.

7) The Contractor shall indemnify the Employer against the reduction in manufacturer's guarantee resulting from use before practical completion.

8) If it has been agreed that the Contractor may use the permanent lighting then the following shall apply:

   a) Diffusers shall be replaced with new just before Practical Completion.

   b) Exposed parts of the luminaire shall be protected against paint splashes and other marks.

   c) Any separate (e.g. fluorescent) lamps that are used during this period shall be removed and replaced by new, permanent lamps immediately prior to Practical Completion.

   d) Where LED fittings with integral lamps are used, the Contractor shall provide financial compensation for the proportion of the fitting life that has been lost due to this usage. This shall be based on the total cost of the fitting and an expected lifespan of 60,000 hours. The running hours shall be logged by the Contractor and certified by the Contract Administrator.

   e) Use of the permanent lighting installation and temporary / replacement lamps shall not incur any additional cost to the contract.

1B-29 SCHEDULE OF RATES

The Contractor shall provide a full quantified schedule of rates which shall:

1) Be provided with 14 days of being appointed

2) Shall be a Bill of Quantities with a total that matches the contract price.

3) List all materials, equipment and quantities applicable to the works.

4) Be broken down into 1st fix, 2nd fix and fit out for each service element as defined in the Tender Analysis.

1B-30 CDM REGULATIONS

CDM regulations documentation, specific risk assessments etc. shall be provided as follows:

1) In electronic format

2) Mechanical and Electrical Contractors shall agree number of paper copies to be issued for comment with the Principal Contractor/Principal Designer and Engineer, for tender purposes assume 2 (two).

3) Manufacture / installation works shall not commence until the documentation has been returned without any outstanding comments from the Principal Contractor/Principal Designer and Engineer, all comments shall be addressed prior to final copy being issued for inclusion in the Health and Safety File.

1B-31 LABELLING OF EQUIPMENT

Each item of plant and equipment shall bear a metal nameplate giving the maker's name, serial number and relevant performance data. In addition all items of plant and equipment shall be provided with site specific reference labelling, for details refer to Section 3 of this specification.

1B-32 EXISTING ASBESTOS INSTALLATION

Reference to the Contract preliminaries shall be undertaken to ascertain any work associated with removal of existing asbestos. The Contractor shall also review the Client's Asbestos Register to become cognisant with all known locations of asbestos and any risks associated with the presence of asbestos

1B-33 PRESSURE REGULATION DOCUMENTATION AND COMPLIANCE

All certification/documentation in compliance with the Pressure Equipment Directive (97/23/EC) and all latest amendments shall be provided.

All equipment installed under this contract and subject to this regulation must be certified and all documentation included within the O & M Manuals.

Failure to provide necessary certification shall render the equipment/system non-functional.

The Mechanical Contractor and Main Contractor shall be liable for any subsequent costs associated with the non-compliance.

The entire installation shall comply in full with the pressure regulations and shall include:

1) Provision of all safety pressure, combined temperature & pressure relief valves and the like.

2) Provision of individual pressure test certificate for all components covered by the regulations. Type testing is not acceptable.

3) Provide, or update an existing when modifying a system, a written scheme of examination in accordance with the regulations, employ a competent person to complete this on the Mechanical Contractor's behalf if this cannot be completed in house.

All necessary attendances shall be included by the Mechanical Contractor and for compiling all necessary paperwork required to enable the written scheme of examination to be compiled.

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1B-34 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS

For the purposes of the Construction (Design and Management) Regulations, the Main Contractor shall be nominated as and assume the duties of Principal Contractor as defined and set out in those Regulations.

Notwithstanding the requirements of the above clause, the Contractor shall be bound to abide by and implement all regulations, byelaws or other legislation relevant to the health, safety and welfare of all persons on or about the works or likely to be affected by the execution of the works.

1B-35 HEALTH AND SAFETY PLAN

The Contractor shall, in conjunction with the CDM Principal Designer, where necessary, amend, adapt, and expand the Health and Safety information provided contained within the tender documents to produce a coherent Construction Phase plan for the project. The plan shall be implemented and monitored and where necessary, adapted, amended or expanded to reflect changes in circumstances which may arise during the construction phase of the project.

1B-36 PERSONNEL

The Contractor shall:

1) Ensure suitably qualified personnel are responsible for preparing, implementing and monitoring the Health and Safety Plan for the duration of the construction phase of the project.
2) Obtain the prior written approval of the CDM Principal Designer before changing any of the personnel referred to above.

1B-37 HAZARDS OF HEALTH AND SAFETY GENERALLY

The Contractor shall advise the CDM Coordinator immediately of any deficiencies in the Pre-tender Health and Safety information provided or of unforeseen hazards to health and safety which may become apparent as the project proceeds.

1B-38 CONTRACTORS

The Contractor shall take all necessary measures to satisfy himself that all Contractors, whether appointed by him directly or not, are competent and have allocated sufficient resources to comply with the requirements on Contractors imposed by the latest Construction (Design and Management) Regulations.

1B-39 INSTRUCTION OF EMPLOYER'S STAFF

The Contractor shall, in conjunction with their Specialists and Commissioning engineer, instruct the employer's staff.

Instruction shall not commence until the following has been achieved:

1) Full commissioning of all services.
2) Checking Verification of Systems.
3) Random Checks of system(s) by Engineer.
4) Note: client instruction shall not take place on same day as commissioning activities for any system.

A programme for all instruction / demonstrations shall be developed in advance and issued to the following parties:

1) Main Contractor
2) The Contractor and his Specialists / Sub-Contractors.
3) Commissioning specialist
4) Electrical/Mechanical Contractor
5) Client's facilities management representatives.
6) Client user group(s) representative.
7) Contract Administrator
8) Engineer

For each system the following procedure shall be used:

1) Prepare documentation for instruction including:
   a) Relevant as fitted drawings / technical drawings.
   b) Relevant section of the O&M manual, including Job specific information, operating instructions, maintenance instructions etc.
   c) Final commissioning results.
2) An invitation to attend the client instruction shall be issued to the parties detailed above at least seven days before the date of the instruction. Invitation shall include:
   a) Electronic (PDF) copies of all of the documentation for commissioning described above.
   b) Agenda for the day's activities developed from the minimum requirements detailed below.
   c) Pro-forma sign off sheet for all attendees.
3) The following parties are required to attend from the contracting team.
   a) The Contractor and their Specialists / Sub-Contractors.
   b) Commissioning specialist
   c) Main Contractor
4) Agenda for system instruction, the following sets out the minimum requirements:
   a) Tour of installed system including identifying all key parts of the system and demonstrating these are correctly indicated on the as fitted drawings.

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b) Presentation of commissioning results and demonstrate system operating correctly.

c) Presentation of operating and maintenance manuals.

d) Demonstrate day to day and emergency operating procedures.

e) Any discrepancies identified during the demonstration shall be scheduled by the Contractor along with actions / programme for rectification.

Formal acceptance of the system shall occur when all parties are satisfied with the system and understand correct operation, all parties shall then sign the pro-forma described above.

The Contractor shall include in their tender and programme sufficient time to incorporate the client instruction methodology described above.

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Section Two (A)

General Installation Clauses - Pipework

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2A-1 GENERAL REQUIREMENTS

The Contractor shall supply, install and commission the pipework installations as detailed on the Tender drawings and within this specification, employing skilled personnel to the standards described.

2A-1-1 DEFINITIONS

Refer to the definitions contained within the BESA TR series of documents and the following:

DEFINITIONS / ABBREVIATIONS			
ACoP	Approved Code of Practice	DZR	Copper alloy with inhibiter & heat treatment to prevent dezincification
AMETAL	Alloy developed for chilled water and cold fluid applications to resist corrosion	GBV	Globe Valve
AAV	Automatic Air Vents	GM	Gun Metal
BCWS	Boosted Cold Water Service	GV	Gate Valve
BESA	Building Engineering Services Association	HTHW	High Temperature Hot Water
BFV	Butterfly Valve	LTHW	Low Temperature Hot Water
BV	Ball Valve	MAV	Manual Air Vents
CHW	Chilled Water Service	MCWS	Mains Cold Water Service
CI	Cast Iron	MI	Malleable Iron
CS	Commissioning Station, close coupled fixed orifice type	MTHW	Medium Temperature Hot Water
CST	Cast Steel	NRV	Non-Return Valve
DHWS	Domestic Hot Water Service	OP	Orifice Plate
DI	Ductile Iron, Spheroidal Graphite Iron (SGI) or graphite rich cast iron	SS	Stainless Steel
DPR	Differential Pressure Regulator	TCWS	Tank Cold Water Service
DRV	Double Regulating Valve	WRAS	Water Research Advisory Service

2A-1-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section defines common requirements for all pipework systems and shall be read in conjunction with the standards for the particular pipework system used and the specific sections of this specification.

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the pipework installations.

2A-1-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BESA SUS 01: Guide to good practice: Heat metering	BS EN 1287 Sanitary tapware. Low pressure thermostatic mixing valves. General technical specifications
BESA TB005: Controlling legionella	BS EN 1515 Flanges and their joints. Bolting
BESA TB013: Thermal storage	BS EN 9606 Qualifications testing of welders. Fusion welding
BESA TB015: Leak checking – Direct and indirect methods	BS EN 10216 Seamless steel tubes for pressure purposes
BESA TB017: Pressure testing with changing ambients	BS EN 10217 Welded steel tubes for pressure purposes
BESA TB032: Protection of pipework penetrating fire-separating elements	BS EN 10220 Seamless and welded steel tubes. Dimensions and masses per unit length
BESA TB036: Pinhole corrosion in pipework	BS EN 10226 Pipe threads where pressure tight joints are made on the threads
BESA TR 3: Guide to good practice – Jointing of copper and its alloys	BS EN 10241 Steel threaded pipe fittings
BESA TR 5: Welding of carbon steel pipework	BS EN 10242 Threaded pipe fittings in malleable cast iron
BESA TR 11: Guide to the use of plastic pipework	BS EN 10253 Butt welding pipe fittings
BESA TR 20/1: Low temperature hot water heating (LTHWH)	BS EN 10255 Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions
BESA TR 20/2: Medium temperature hot water (MTHW)	BS EN 12327 Gas Infrastructure. Pressure testing, commissioning and decommissioning procedure
BESA TR 20/3: High temperature hot water (HTHW)	BS EN 13501 Fire classification of construction products and building elements

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STANDARDS	
BESA TR 20/4: Hot water service (HWS)	BS EN 15216, Characterization of waste – Determination of total dissolved solids (TDS) in water and eluates
BESA TR 20/5: Cold water service (CWS)	BS EN 27888, Water quality – Method for the determination of electrical conductivity
BESA TR 20/6: Chilled water (CW)	BS EN ISO 228 Pipe threads where pressure tight joints are not made on the threads
BESA TR 20/7: Condenser / Cooling water	BS EN ISO 1456 Metallic and other inorganic coatings
BESA TR 20/8: Steam & condensate	BS EN ISO 5667-3, Water quality – Sampling – Part 3: Guidance on the preservation and handling of water samples
BESA TR 20/9: Natural gas	BS ISO 5667-5, Water quality – Sampling – Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems
BESA TR 30: Heat pump guide	BS EN ISO 9963-1, Water quality – Determination of alkalinity – Part 1: Determination of total and composite alkalinity
BESA TR 36: Guide to good practice – Installation of rainwater harvesting in non-residential buildings	BS EN ISO 10497 Testing of valves. Fire type testing requirements
BESA TR 37: Installation of combined heat and power	BS ISO 10523, Water quality – Determination of pH
BESA TR 38: Installation of biofuel heating	BS ISO 17381, Water quality – Selection and application of ready-to-use test kit methods in water analysis
BESCA Welding Test Centre Certification	BSRIA BG 29/2012 Pre-commission cleaning of pipework systems
BS 143 and BS 1256 Threaded pipe fittings in malleable cast iron and cast copper alloy	BSRIA BG 50/2013 Water treatment for closed loop heating and cooling systems
BS 1427 Guide to on-site test methods for the analysis of waters	BSRIA BG57/2015 Legionnaires' Disease - Risk Assessment
BS 1710 Specification and identification of pipelines and services	BSRIA BG58/2015 Legionnaires' Disease – Operation and Maintenance Log Books
BS 2486 Recommendations for treatment of water for steam boilers and water heaters	Gas Safety Regulations
BS 2633 Specification for Class I arc welding of ferritic steel pipework for carrying fluids	HSE GS4 Safety requirements for pressure testing
BS 2879, Specification for draining taps (screw-down pattern)	HSE L8 Guidance on regulations Legionnaires' Disease – The Control of Legionella bacteria in water systems
BS 2971 Specification for Class II arc welding of carbon steel pipework for carrying fluids	HSE L56 Safety in the installation and use of gas systems and appliances
BS 6068 & BS EN 872 Water Quality Determination of suspended solids	HSE L80 A guide to the Gas Safety (Management) Regulations 1996, Guidance on Regulations
BS 6644 Specification for selection, installation, inspection, commissioning, servicing and maintenance of gas-fired boilers of rated inputs between 70 kW and 1.8MW net	HSE L82 A guide to the Pipelines Safety Regulations 1996
BS 6798 Specification for selection, installation, inspection, commissioning, servicing and maintenance of gas-fired boilers of rated input not exceeding 70kW net	HSE L122 Safety of pressure systems
BS 7592, Sampling for Legionella bacteria in water systems – Code of practice	HSE HSG 139 The safe use of compressed gases in welding, flame cutting and allied processes
BS 8537 Copper & copper alloys. Plumbing fittings	HSE HSG 253 The safe isolation of plant and equipment
BS 8552 Sampling and monitoring of water from building services closed systems – Code of practice	HSE HSG 274 Legionnaires' disease technical guidance
BS 8558 Guide to the design, installation, testing and maintenance of services supply water for domestic use within buildings and their curtilages	Institute of Gas Engineers and Managers (IGEM) General Series Standards (G)
BS 9999 Code of practice for fire safety in the design, management and use of buildings	Institute of Gas Engineers and Managers Legislation Series (GL)
BS EN 545, 598 & 969 Ductile iron pipes, fittings, accessories and their joints for water, sewage, gas pipelines respectively	Institute of Gas Engineers and Managers Gas Measurement Series (GM)
BS EN 806 Specifications for installations inside buildings conveying water for human consumption	Institute of Gas Engineers and Managers Safety Series Standards (SR)
BS EN 1057 Copper & copper alloys. Seamless, round copper tubes	Institute of Gas Engineers and Managers Transmission and Distribution Series Standards (TD)
BS EN 1092 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories	Institute of Gas Engineers and Managers Utilization Series Standards (UP)
BS EN 1254 Copper and copper alloys. Plumbing fittings	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

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Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2A-1-4 SYSTEM MATERIAL SELECTION

All pipework and components shall be selected from the tables on the following pages in respect to the type of materials required.

PIPEWORK SELECTION TABLE	LTHW
Mild Steel Heavy Grade to BS EN 10255 and BS EN 10220	✓
Mild Steel to ASME / ASTM A106 Grade B Schedule 40	O
Victaulic Grooved Mild Heavy Steel	O
Galvanised Mild Steel Heavy Grade to BS EN 10255 and BS EN 10240	X
Stainless Steel 316L	O
Copper Half-Hard Tube to BS EN 1057 R250	O
Copper Annealed Tube to BSEN 1057 R220	X
Press fit, Stainless Steel AISI 316 and Copper BS EN 1057 R250 / R290 (Notes 1 & 2)	O
Uponor MLCP (Multi-layer Composite Pipe) Systems BS EN ISO 21003 (Notes 1 & 3)	O
George Fischer Insteflex (Note 1)	X
PE80 Polyethylene (Note 1)	X
ABS Durapipe SuperFLO (Note 1)	X

PIPEWORK SELECTION TABLE	DHWS	MDHWS	BDHWS	BURIED WATER	BOILER CONDENSATE
Mild Steel Heavy Grade to BS EN 10255 and BS EN 10220	X	X	X	X	X
Victaulic Grooved Mild Heavy Steel	X	X	X	X	X
Galvanised Mild Steel Heavy Grade to BS EN 10255 and BS EN 10240	X	X	X	X	X
Stainless Steel 316L	O	O	O	X	X
Copper Half-Hard Tube to BS EN 1057 R250	✓	✓	✓	X	X
Copper Annealed Tube to BSEN 1057 R220	X	X	X	X	X
Press fit, Stainless Steel AISI 316 and Copper BS EN 1057 R250 / R290 (Notes 1 & 2)	O	O	O	X	X
Uponor MLCP (Multi-layer Composite Pipe) Systems BS EN ISO 21003 (Notes 1 & 3)	O	O	O	X	X
George Fischer Insteflex (Note 1)	O	O	O	X	X
PE80 Polyethylene (Note 1)	X	X	X	O	X

PIPEWORK SELECTION TABLE	DHWS	HCWS	ACWS	BURIED WATER	BOILER CONDENSATE
PE80 Barrier Protected Polyethylene (Contaminated Ground Conditions) (Note 1)	X	X	X	✓	X
ABS Durapipe SuperFLO (Note 1)	X	X	X	X	✓

PIPEWORK SELECTION TABLE	OVER FLOW & WARNING PIPES	VENTS
Mild Steel Heavy Grade to BS EN 10255 and BS EN 10220	X	X
Victaulic Grooved Mild Heavy Steel	X	X
Galvanised Mild Steel Heavy Grade to BS EN 10255 and BS EN 10220	X	X
Stainless Steel 316L	O	X
Copper Half Hard Tube to BS EN 1057 R250	✓	✓
Copper Annealed Tube to BSEN 1057 R220	X	X
Press fit, Stainless Steel AISI 316 and Copper BS EN 1057 R250 / R220 (Notes 1 & 2)	O	X
Georg Fischer Installax (Note 1)	X	X
PE63 Polyethylene (Note 1)	X	X
PE80 Barrier Protected Polyethylene (Contaminated Ground Conditions) (Note 1)	X	X
ABS Durapipe SuperFLO (Note 1)	X	X

Note 1 - **Installed strictly in accordance with the manufacturer's best practice installation guidelines.**

Note 2 - **Pressfit refers to Geberit Mapress and Pegler Yorkshire Xpress as these are the only press fit systems permitted.**

Note 3 - **Final branch connections only within residential areas only (i.e bedroom en-suites) – not to be used on mains distribution.**

✓	Default material / jointing system that shall be included for at tender and used for the installation.
X	Shall not be used.
O	May only be used when specifically allowed in particular section of this specification.

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2A-1-5 COMPONENT SPECIFICATION TABLES

LOW TEMPERATURE HOT WATER (LTHW) HEATING SYSTEM				
PRESSURE RATING - PN 16 UNLESS DETAILED OTHERWISE IN PARTICULAR SECTION				
VALVE / COMPONENT	SIZE RANGE (Ø)	VALVE TYPE	VALVE / COMPONENT MATERIAL(S)	NOTES
Isolation	15mm to 50mm	GV or BV	DZR or Bronze	All areas
	65mm to 200mm	GV	DI or CI	All areas
	65mm to 200mm	BFV	CI, SS or DI EPDM seat lever operated SS disc	Only be used for external & plant room areas
	> 200mm	GV	CI, SS or DI	All areas
	> 200mm	BFV	SS or DI EPDM seat gear operated SS disc	Only used for external & plant room areas
Regulation	15mm to 50mm	DRV	DZR or Bronze	
	65mm to 200mm	DRV	DI, GM or CI	
	> 200mm	DRV	DI, GM or CI	
Flow Measurement & Regulation	15mm to 50mm	CS – DRV + OP	DZR, Bronze or SS	
	65mm to 150mm	CS – DRV + OP	SS or CI	
	> 150mm	CS – DRV + OP	SS or CI	
Non-Return Valve	15mm to 50mm	NRV – Gravity	Bronze, GM, DZR or DI	Pressure drop < 1 kPa
	65mm to 200mm	NRV – Gravity	DI or CI	Pressure drop < 1 kPa
	> 200mm	NRV – Gravity	DI or CI	Pressure drop < 1 kPa
Wafer Non-Return Valves	> 50mm	NRV – Double door wafer	DI or CI	Pressure drop < 1 kPa Only if permitted by Engineer
Orifice Plates	All Sizes	OP	DZR, SS & GM	
Strainers with test points	15mm to 50mm	ST	Bronze, DZR or GM SS mesh cages	Pressure drop < 2 kPa
	> 50mm	ST	GM or DI SS mesh cages	Pressure drop < 2 kPa
Union Joints	15mm to 65mm	Navy	MI, GM & SS	Navy pattern
Internally galvanised pipes, valves and fittings shall not be permitted.				

DOMESTIC HOT AND COLD WATER SYSTEMS INCLUDING BOOSTED AND MAINS COLD WATER SERVICES (DHWS, MCWS, BCWS AND TCWS)				
PRESSURE RATING - PN 16 UNLESS DETAILED OTHERWISE IN PARTICULAR SECTION				
VALVE / COMPONENT FUNCTION	SIZE RANGE (Ø)	VALVE TYPE	VALVE / COMPONENT MATERIAL(S)	NOTES
Isolation	15mm to 54mm	GV or BV	DZR and SS	All areas
	> 54mm	GV	DZR and SS	All areas
	> 54mm	BFV	DZR and SS	Only be used for external & plant room areas
Final connections to outlets for re-washering only.	15mm to 22mm	BV	DZR and SS	Full Bore, lever operated chromium plated where exposed.
Regulation	15mm to 54mm	DRV	DZR and SS	LSVs not permitted for regulation purposes
	> 54mm	DRV	DZR and SS	LSVs not permitted for regulation purposes
Flow management and regulation	15mm to 54mm	CS – DRV + OP	DZR and SS	
	> 54mm	CS – DRV + OP	DZR and SS	
Check Valves	15mm to 54mm	NRV – Gravity	DZR and SS	Low pressure drop
	> 54mm	NRV – Gravity	DZR and SS	Low pressure drop
Orifice Plates	15mm to 54mm	OP	DZR and SS	
	> 54mm	OP	DZR and SS	

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DOMESTIC HOT AND COLD WATER SYSTEMS INCLUDING BOOSTED AND MAINS COLD WATER SERVICES (DHWS, MCWS, BCWS AND TSVS)				
PRESSURE RATING = PN 16 UNLESS DETAILED OTHERWISE IN PARTICULAR SECTION				
VALVE / COMPONENT FUNCTION	SIZE RANGE (S)	VALVE TYPE	VALVE / COMPONENT MATERIAL(S)	NOTES
Strainers complete with integral test points	15mm to 54mm	ST	DZR and SS SS mesh cages	Pressure drop < 2 kPa
	> 54mm	ST	DZR and SS SS mesh cages	Pressure drop < 2 kPa
All components above shall be Water Regulations and WRAS approved. All BV's installed on water services circuits shall be of the extended spindle type for application of insulation to ensure fully vapour sealed.				

2A-1-6 COMPONENT MANUFACTURERS

All components shall be manufactured and supplied by one of the manufacturers scheduled in the table below. All components of the same type shall be from the same manufacturer to ensure consistency across the project.

COMPONENT	ACCEPTABLE MANUFACTURER
Differential Pressure Control and Flow Limiting Valves	Oventrop UK Limited Samson Controls Limited Frese Limited Crane / Hattersley Pegler Yorkshire Group Limited
Thermostatic Mixing Valves	Grohe Caradon Mira Limited Horne Engineering Limited Pegler Yorkshire Group Limited
Test Points	Oventrop UK Limited Crane / Hattersley Pegler Yorkshire Group Limited
End of line DHW temperature controlled return valves / temperature maintaining valves	Oventrop Aquastrom Frese Limited Pegler Yorkshire Group Limited
End of Line Temperature Limiting Valves	Oventrop UK Limited
Automatic Air Vents	Spirotech Limited 'Spirotop'
Expansion bellows	BOA Flexible Solutions Limited Pipe Solutions Ltd Bellows Technology Ltd FLEXEJ Ltd
Anti-Vibration Equipment	TEK Ltd
All others including IV, CS, etc.	Crane / Hattersley Oventrop UK Limited Pegler Yorkshire Group Limited

2A-2 GENERAL REQUIREMENTS FOR PIPEWORK SYSTEMS

2A-2-1 INTRODUCTION

This Section of the Specification details the general requirements applicable to all pipework systems and shall be read in conjunction with the detailed requirements as specified.

The Contractor shall adhere to the good practice guidelines detailed in the BSRIA pre-commissioning guide in order to minimise the works required at the pre-commissioning stage of the project.

2A-2-2 COMPLIANCE WITH LOCAL WATER AUTHORITY

The Contractor shall:

1) Issue all water services (domestic and external services, etc.) working drawings to the local authority for their comment with regard to water regulations and local requirements (except where Contractor is able to self-certify the scheme with the local authority).

2) Agree with local authority all tests and certification required by the water authority before connection of the water supply to the building.

3) Ensure that any certification required is submitted within the time scales specified by the authority in order to ensure that the connection of the water supply is not delayed.

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4) Ensure that all systems fully comply with the local water authority's particular requirements.

2A-2-3 WATERSAFE REGISTRATION AND WATER SERVICE CONNECTIONS

The Contractor shall be a "WaterSafe" Approved Contractor and fully adhere to the customer commitments, conditions of membership and scheme rules of WaterSafe. All operatives shall have undergone all necessary training and shall provide proof of competence before completing any work on domestic water or incoming water service systems.

The WaterSafe Approved Contractor shall carry out all necessary legal notification to the water supplier.

On completion of works by the WaterSafe Approved Contractor they shall issue a Completion Certificate to prove full compliance with Water Fittings Regulations and Byelaws.

All pipework, branches and final connections to all baths, basins and sink taps, shower fittings, W.C. cisterns etc. shall be undertaken by the Tenderer. The whole installation shall be carried out to this Specification by a WaterSafe qualified Plumber.

All hot and cold water taps and spray taps to basins shall be supplied under a separate contract unless detailed otherwise in the particular clauses.

All connections shall be completed in tube to match the distribution system, flexible connections (stainless steel or otherwise) shall not be used.

2A-2-4 STAMPED FITTINGS

All fittings, such as control valves, stop cocks, ball valves and emptying taps etc., shall bear the WRAS stamp. All necessary testing fees shall be included by the Contractor.

All materials, valves and fittings shall be **CE marked** to prove the product meets the requirements of the applicable EC directives.

CE marking consists of the CE-logo and, if applicable, the four-digit identification number of the notified body involved in the conformity assessment procedure.

Failure to comply with this requirement shall require the Contractor to replace any components without the relevant CE marking with a compliant product at their own expense.

2A-2-5 PIPEWORK CLEARANCES

Pipework shall be fixed to give the following minimum clearances between the face of the pipe or, if insulated, the face of the insulation and the adjacent surface.

PIPEWORK CLEARANCES		
SERVICE TYPE	ADJACENT SURFACE	MINIMUM SPACING
Any	Wall	25mm
Any	Ceiling	50mm
Any >30°C <100°C (Insulated)	Any >30°C <100°C (Insulated)	25mm
Any >30°C <100°C (Insulated)	Domestic Water <20°C (Insulated)	180mm (Hot service shall be above cold service)
Any (un-insulated)	Any (un-insulated)	25mm
Any (insulated)	Any (un-insulated)	90mm
Any (insulated)	Conduit or Trunking	50mm
Any (un-insulated)	Conduit or Trunking	150mm
Refer to additional requirements detailed in specialist pipework systems (e.g. Instaflex etc.)		
In addition to the above, sufficient space shall also be allowed to facilitate easy application of thermal insulation materials of the thickness specified elsewhere in this specification and allow access for maintenance or removal without disturbance of the remaining pipework or services.		

2A-2-6 EXPANSION AND CONTRACTION

The Contractor shall be responsible for the design and installation of all systems necessary to allow provision for free movement for expansion and contraction of the pipework systems and building movement / settlement. Movement due to expansion and contraction shall be taken up by:

1) Changes of direction or the offsetting of pipework to form loops and offsets. These shall be formed by using welded or pulled bends shop-fabricated with flanged ends, the whole assembly being annealed after manufacture to remove any stresses due to welding. When installing offsets at least 50% cold draw shall be applied.

2) Specialist systems, such as Instaflex and plastic pipework systems, have increased expansion rates and particular requirements, manufacturers published guidance shall be followed in full, expansion bellows / joints shall not be used.

3) Higher rates of expansion and specific methods of controlling expansion associated with specialist pipework systems shall be taken into account and methods employed agreed with the manufacturer and Engineer.

4) Where natural flexibility free movement solutions cannot be employed, the provision of expansion joints or bellows shall be installed in accordance with the manufacturer's instructions for both installation details and guiding. Expansion joints or bellows shall only be used when offsets or loops are not possible. Expansion joints shall be pre-cold-drawn with a retaining clip, which must be removed after installation. Expansion joins shall be capable of at least 2,000 complete reversals of movement at the system working conditions. Expansion joints shall be capable of withstanding a pressure 1.5 times their design pressure (or system test pressure if greater) without deformation.

5) Anchors and guides shall be supplied and installed to ensure that all movement is taken up by the method adopted. The anchors shall be of sufficient strength to withstand the anticipated forces and a check shall be made that the building structure, to which the anchors and guides are attached, is adequate for the loads imposed. Anchors shall be provided to prevent excess stresses to pipework joints and equipment.

6) Detailed arrangements of all anchors and guides shall be submitted to the Engineer and Structural Engineer for comment before manufacture commences.

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In the event that natural flexibility cannot be used due to building fabric restraints and bellows are required to be installed:

- All bellows shall be thick wall spirally wound multi-layered all stainless steel (316L) quality units with a corrosion resistant inner ply or sleeve for all pipework.
- Additionally, for copper pipework the bellows shall be bronze construction to avoid flux corrosion.
- All steam, HTHW & MTHW shall be twin wall stainless steel type with leak indication.

2A-2-7 BRACKETS AND FIXINGS GENERALLY

The Contractor shall design, supply and install all brackets and fixings, including any secondary steelwork, necessary to make the project complete.

All insulated services shall be provided with proprietary insulated pipe supports as detailed in the thermal insulation standards of this specification where pipework is insulated.

Each pipe support shall:

1) Be arranged as near as possible to joints.
2) Take its due proportion of pipe and component weights.
3) Allow for expansion and contraction.
4) Support the pipework via rollers, chairs and flat iron stirrup guides as appropriate.
5) Meet any structural constraints imposed by the Structural Engineer.
6) Be provided with fixings into structure (i.e. Rawlbolt, Rawlplugs etc.) shall be suitable for the load and the material being fixed to and installed fully in accordance with the manufacturer's recommendations.
7) Details of all types and makes of brackets and fixings to be used shall be given to the Engineer prior to ordering or manufacturing and their comment obtained.
8) Where proprietary pipework and jointing systems are agreed then all brackets / pipe supports shall be as recommended by the particular system manufacturer in terms of type, design and centres.
9) All supports with protruding bolts or threaded rods shall be provided with proprietary end caps to protect eyes and skin from injury. End caps shall be provided to all bolts and rods irrespective of height due to risk during routine maintenance and servicing.

Pipe rings shall be used on services, which do not require a vapour seal and shall:

1) On plain mild steel tube, up to 50mm (inclusive) be black japanned malleable iron.
2) On chromium plated or stainless tubes shall be of the same material as the pipe.
3) On copper exposed to view be polished cast bronze.
4) In all other cases shall be Munsen ring type.

PIPEWORK SUPPORT METHODS	
LOCATION / PIPEWORK TYPE	SUPPORT METHOD WHICH SHALL BE EMPLOYED
Within plant rooms, tank rooms, risers	Supported on or suspended from rolled steel angles, channel or 'unistrut' system either galvanised or painted
Where external to building or within humid environments	Supported on or suspended from rolled steel angles, channel or 'unistrut' system all of which shall be hot dip galvanised after manufacture
Un-insulated pipework exposed to view and fixed to partitions / walls	Screw fixed school board brackets
Un-insulated pipework exposed to view and fixed to partitions / walls in clean environments, healthcare premises and catering areas	Screw fixed school board brackets, hospital pattern with extended stem for ease of cleaning
Insulated pipework	As detailed in 'thermal insulation' section of this specification

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Pipework supports shall be provided at intervals not greater than those detailed in the following table:

PIPEWORK SUPPORTS - MAXIMUM INTERVAL BETWEEN SUPPORTS (IN METRES)														
NOMINAL SIZE (MM)	HEAVY GRADE STEEL		COPPER		GROOVED STEEL		STAINLESS STEEL PRESS FIT		COPPER PRESS FIT		ABS @ < 20°C		PE	
Note:	H	V	H	V	H*	V*	H*	V*	H*	V*	H*	V*	H*	V*
≤16	2	2.5	1.2	1.5	2	2.5	1.5	2	1.2	1.5	0.5	0.7	0.2	0.3
≥17 and ≤23	2	2.5	1.5	2	2	2.5	2.0	2.5	1.5	2	0.6	0.9	0.3	0.5
≥24 and ≤29	2.5	3	1.5	2	2.5	3	2.2	3	1.5	2	0.7	1.0	0.5	0.8
≥30 and ≤36	2.5	3.5	2	2.5	2.5	3.5	2.5	3.5	2	2.5	0.8	1.2	0.7	0.8
≥37 and ≤43	3	4	2.3	2.5	3	4	3	4	2.3	2.5	0.9	1.3	0.8	1
≥44 and ≤55	3.5	5	2.5	2.8	3.5	5	3.5	5	2.5	2.8	1.0	1.5	0.9	1.1
≥56 and ≤68	4	6	2.7	3	4	6	4	6	2.7	3	1.1	1.6	1.0	1.2
≥69 and ≤81	5	7	2.9	3.3	5	7	5	7	2.9	3.3	1.2	1.8	1.1	1.4
≥82 and ≤109	6	10	3	3.5	6	10	6	10	3	3.5	1.2	1.8	1.2	1.6
≥110	7	12	3.3	3.8	7	12	7	12	3.3	3.8	1.3	1.9	1.3	1.8

Notes: H=Horizontal spacing, V = vertical spacing

*- Refer to manufacturer's specific requirements for additional support locations to suit jointing method

For the plastic pipework systems, the manufacturer's bracket and support systems shall be employed throughout to their recommended spacing for horizontal and vertical pipework distribution

Additional supports shall be provided as detailed in BESA documents (e.g. double supports on low level exposed pipework, additional supports on push fit systems etc.)

All nuts & bolts on brackets, flanges, equipment, etc. shall:

1) Be high grade (8.8 grade as a minimum).
2) Shall have a washer under the bolt.
3) Bolts shall be of appropriate length with no more than 2-3 threads showing but visible indication that all the nut thread is used (i.e. not too short).

2A-2-8 EQUIPMENT SUPPORT AND PROTECTION

All items of plant shall be provided with proprietary stands or supports and these shall be:

1) Provided whether shown on the tender drawings or not.
2) Be independent of the adjacent distribution systems (ductwork or pipework, etc.).
3) Where supported from the floor, legs shall be mounted on a weight bearing up stand, which extends at least 50mm above finished floor level in order to maintain floor finish integrity.
4) Details of supports shall be supplied to both the Engineer and Structural Engineer for comment prior to manufacture.
5) Supports shall be manufactured from steel, painted before erection, except when installed externally or in a damp environment where the supports shall be hot dip galvanised after manufacture.
6) Where located on a flat roof, support shall be provided by a specialist support system which shall:
   a) Bear weight onto the roof membrane without causing damage or undue stress.
   b) Be located over structural members.
   c) Meet the Structural Engineer's requirements.
   d) Be manufactured by Roof-Pro Ltd, Tel 01234 843790 or approved equivalent.
7) Any exposed moving machinery (i.e. drives, belts, fan blades, chains, projecting set screws, etc.) shall be provided with protective guards which shall:
   a) Be manufactured from robust hot dipped galvanised welded steel open mesh and frame.
   b) Be easily removed for maintenance access.
   c) Do not vibrate or transmit vibration to the building structure or equipment served.
   d) To facilitate speed checks, removable bolted sections shall be provided opposite the shaft ends.

2A-2-9 CONNECTION TO PLANT AND COMPONENTS

Connection to plant and components shall:

1) Be completed via suitable flexible connections to any item of rotating machinery or equipment likely to vibrate.
2) Be provided with unions/ flanges and isolating valves (whether shown upon the drawings or not) to allow the plant/ component to be replaced without disrupting the service or any adjacent services.
3) Not support the plant/ component.

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2A-2-10 ANTI-VIBRATION MOUNTINGS

Specialist anti-vibration mountings and flexible connections shall be designed and provided to all items of rotating or vibration producing plant, these shall:

1) Be selected by the manufacturer making allowance for building structure, weight and characteristics of the equipment supported.
2) Be of the laterally stable steel spring type mounting.
3) In the case of small pumps (<1.5 l/s) neoprene mountings are acceptable.
4) Limit vibration transmission to the structure, degree of isolation (vibration efficiency) shall be at least 95%.
5) Final connections shall be via braided stainless steel flexible connections selected to match the anti-vibration mountings.
6) Prevent any discernible re-radiated noise and vibration to adjacent rooms/ areas either through the building structure or distribution systems.

2A-2-11 FLEXIBLE CONNECTIONS

Flexible connection shall be provided where shown on the drawings, either side of each pump, on all connections to chillers and other centrifugal reciprocating or vibrating equipment and where detailed elsewhere in this specification. They shall:

1) Be line size.
2) Be suitable for working temperatures up to 100°C, the bellows carcass shall be Aramid reinforced throughout or stainless steel hose.
3) Have swivel type flanges/ screwed connections.
4) Be suitable for heating circuits and a design life of 120 months at 100°C and after this time have a minimum burst pressure of 30 bar.
5) The date of manufacture shall be moulded on the bellows. For traceability membranes shall have an indelible identification showing manufacturer, country of origin and the type.
6) Tie bars with rubber top hat washers shall be used where the working pressure exceeds 3 Bar Gauge up to 50mm nominal bore and 2 Bar Gauge for larger sizes. Where untied bellows are used the manufacturers recommendations for anchors and guides shall be followed. Tie bars shall be threaded and their length adjustable.

2A-2-12 FLEXIBLE CONNECTIONS IN DOMESTIC WATER SYSTEMS

On all healthcare and projects where susceptible or high-risk users are present the Contractor shall:

1) Not use flexible connections, except for situations described in HTM04-01A Clause 3.41, specifically:
   a) To allow for vibration of equipment;
   b) To accommodate vertical displacement of high and low baths and sinks;
   c) To facilitate essential maintenance and access of bespoke equipment when no alternative is available.
2) Where fitted, flexible hoses should be kept as short as possible and be kink-free so as not to affect flow.
3) Not use flexible connections to general sanitary ware and taps unless agreed with the Client.
4) Review final connection details and any flexible with the sanitary ware/ tap manufacturer.
5) Review final connection details and any flexible with the Clients Infection Control Officer (or equivalent).
6) Provide an installation that meets the best practice recommendations.
7) Be as short as possible in length.
8) Shall use a suitable alternative to EPDM selected to minimise the forming of biofilms and risk from Pseudomonas/ Legionella, etc.
9) Be WRAS approved.
10) Provide food grade nitrile rubber bellows liner shall with KIWA Watertec Approval for hot water services.

On all other projects, the Contractor shall avoid flexible connections where possible, where unavoidable use of flexible connections shall be agreed with the Design Engineer and shall:

1) Be as short as possible, kink-free and in all cases less than 300mm in length.
2) Shall use a suitable alternative to EPDM selected to minimise the forming of biofilms and risk from Pseudomonas/ Legionella, etc.
3) Be WRAS approved.
4) Provide food grade nitrile rubber bellows liner shall with KIWA Watertec Approval for hot water services.
5) Review final connection details and any flexible with the sanitary ware/ tap manufacturer.
6) Review final connection details and provide a sample flexible connection installation with the Engineer so that the principles of acceptable installation are agreed.
7) Provide an installation that meets the best practice recommendations.

2A-2-13 PIPE CUTTINGS

Piping shall:

1) Be completed in accordance with both the pipe and fitting manufacturer's recommendations using proprietary tools where required.
2) Be cut clean and square with the axis of the pipe (or bevelled edge as required for welding) using a saw, pipe cutting tool or machine.
3) Any lubrication used during cutting shall be in accordance with both the pipe and fitting manufacturer's recommendations.

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4) Be prepared by filing or grinding and all internal burrs shall be removed by filing or reaming.

The Engineer shall require the Contractor to disconnect any pipes for inspection; should inspection reveal any neglect of reaming, the Contractor shall be required to remove, re-fix and retest at their own expense, as much of the pipework as may be deemed necessary by the Engineer.

2A-2-14 TEES AND CROSSES AND BRANCHES

All tees, twin elbows and crosses shall be:

1) Easy sweep pattern.
2) Square pattern on air venting devices.
3) Square pattern on drain cocks.
4) Square pattern on gauges and test points.
5) Square pattern on sensors, if no requirement stated by manufacturer.

2A-2-15 UNIONS

Unions shall:

1) Be generally of malleable iron with two bronze seats, as the Navy pattern.
2) Have galvanised unions for galvanised pipework.
3) Have gunmetal unions for copper pipework.
4) Be fitted on the outlet of each screwed valve except in the case of draw-off points.

2A-2-16 VALVES

All valves shall be consistent across the works, i.e. all isolating valves, regulating valves, etc. on a particular service shall be of the same manufacturer and the same type and appearance.

Wheel or lock shield valves and stopcocks shall be:

1) Fitted where indicated on the drawings.
2) In accordance with the schedules detailed elsewhere in this section of the specification.
3) Fitted with unions adjacent to screwed valves to facilitate maintenance.
4) Complete with a cast iron surface access box indicating service of valve where installed underground.

2A-2-17 MALLEABLE IRON FITTINGS

All malleable iron fittings shall:

1) Be of the banded type, black or galvanised to match pipework material.
2) Be of the easy sweep pattern for all tees.
3) Have inclined angle easy transition pieces not exceeding 30 degrees for reductions and enlargements
4) Have long sweep pattern bends with centreline radius/ nominal bore of not less than 1.5. Where the use of a long sweep fitting would throw the pipework beyond an acceptable distance from the wall when exposed in rooms, short radius fittings can be used after first obtaining the acceptance of the Engineer.

Fabricated fittings shall be used only with written acceptance of the Engineer and if manufacturer's standard fittings are not available.

2A-2-18 FLANGES

Flanges shall be provided on all services for ease of maintenance and for mating to valves, equipment, etc.

Selection of the appropriate flange type, material and specification shall be in accordance with the British Standards detailed at the start of this section and shall:

1) Be at least the same pressure rating as that stated for components elsewhere in this specification.
2) Correlate to the pipework, material, equipment or component as defined in the relevant British Standard material group.
3) Negate any possibility of dezincification of the mating or surrounding materials.
4) Be selected to suit the operating and testing pressures/ temperatures of the system.
5) Have suitable gaskets, refer to BESA TR series documents for relevant service.

2A-2-19 DRAIN COCKS

Drain cocks shall:

1) Be fitted in the following locations:
   a) Where indicated on the drawings.
   b) As detailed in specific sections of this specification.
   c) At all low points on all water systems to ensure complete drainage.
2) Be screw type (removable).
3) Be of a suitable type/ size, refer to table below.
4) Have a chromium plated finish where exposed to view.
5) Be complete with serrated hose connection to retain a rubber hose.
6) Have an operating spindle fitted with a renewable 'O' ring gland.
7) Be fitted within 75mm of the floor and be in accordance with the Water Regulations.

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DRAIN COCK SIZE		
PURPOSE / LOCATION	PIPEWORK SIZE	DRAIN COCK
Plant rooms (drainage only)	≤50mm dia. 51mm to 150mm >150mm	15mm dia. oblique (or 'Y') renewable washer screw down type 25mm dia. lock shield valve & union adapter to serrated hose connection 50mm dia. lock shield valve & union adapter to serrated hose connection
Exposed to view	≤100mm dia. > 100mm	15mm dia. lock shield type 25mm dia. lock shield type
Plant Rooms / Risers / Voids used for flushing	All	Lock shield Valve and Union adapter to serrated hose connection, larger size as recommended by flushing specialist, 25mm dia. minimum
Plant Rooms / Risers where used for fast fill	All	Lock shield Valve and Union adapter to serrated hose connection. Sized to suit system volume, 25mm dia. minimum.

2A-2-20 COMMISSIONING AND BALANCING VALVES

To promote reliable and accurate balancing of water systems, commissioning valves shall be supplied and installed in the pipework systems and shall:

1) Be fitted in the following locations:
   a) Where indicated on the drawings.
   b) As detailed in specific sections of this specification (Whether indicated on drawings or not).
   c) Where required for correct and efficient commissioning.
   d) Generally, be installed on the return of:
      i) Each heating and cooling primary circuit.
      ii) Each heating and cooling secondary circuit.
      iii) Each heating, cooling and recovery battery.
      iv) Each refrigeration machine chilled water evaporator and condenser.
      v) All major plant items e.g. boilers etc.
      vi) All mains and sub-mains leaving plant rooms or main risers.
2) Be either combined (i.e. orifice plate plus DRV close coupled) or discreet (orifice plate on flow with DRV on return). All fixed orifice commissioning sets shall be selected to provide an accuracy of measurement of +/- 5% of design flow rate.
3) Use Venturi measurement devices where an accuracy better than +/- 3% of design flow is to be achieved.
4) Where specifically allowed in writing by the Engineer variable orifice plates may be used on less critical circuits where accuracy shall be at least +/- 10% of design flow.
5) Have a maximum velocity through commissioning set of 1.2m/s up to 50mm diameter, 2.0m/s for 65mm diameter and above.
6) Measurement component shall be installed to manufacturer's recommendations subject to a minimum of 5 pipe diameter of straight pipe upstream, 3 pipe diameters downstream, whichever is the most onerous requirement.
7) All commissioning valves shall be selected such that excessive closing of the valve is not necessary for correct regulation, utilising smaller diameter valves than the adjacent pipework as necessary, Contractor shall include for necessary reducers within their tender. Contractor shall obtain excess pressures and design flow rates from designer prior to ordering commissioning sets.
8) All commissioning valves shall be selected such that they provide sufficient signal for accurate measurement (say 1 – 4.7kPa), low flow units shall be used where necessary to achieve good readings.
9) Where no specific size is indicated, line size commissioning valves shall be included at Tender stage and the final size to be selected when accurate flow rates and pressures are known, the valve sizes shall be confirmed with the Engineer prior to ordering. However, for tender, as the commissioning valve will not necessarily be of full line size, the installation shall provide reducers immediately adjacent to these valves as necessary.

The commissioning stations (CS) shall be installed with sufficient best practice straight run of pipework either side of the valves fully in accordance with the valve manufacturer's best practice recommendations.

Both the Engineer and the Commissioning Engineer shall review all commissioning valve selections. Valve selection information shall be scheduled. The schedule of information shall include:

1) Pressure drop for each valve, signal strength (between 1 – 4.7kPa).
2) Flow rate.
3) Size of valve.
4) Associated pipeline size.

This schedule shall be provided in sufficient time, minimum of 10 working days, for all comments to be returned and implemented prior to the commissioning valves being ordered.

2A-2-21 DIFFERENTIAL PRESSURE REGULATORS AND DIFFERENTIAL PRESSURE COMMISSIONING STATIONS

Differential pressure regulators (DPR) regulating and differential pressure commissioning stations shall be provided as indicated upon the Tender drawings, which shall:

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1) Have a worst acceptable accuracy of +/- 5% of design sub-circuit pressure.
2) Have a bronze body on systems operating below 120°C. Cast iron shall be an acceptable alternative on 65mm diameter and above.
3) Have a pressure rating to match system, subject to a minimum pressure rating of PN16 (or greater depending on media fluid).
4) Have a maximum port velocity of 2m/s.
5) Have a minimum available adjustment +/- 25% of design flow rate.
6) Be capable of operating against pressure development of system pump, subject to the following minimums:
   a) 200kPa for valves up to 50mm diameter.
   b) 350kPA for valves 65mm diameter and above.
7) Have a maximum pressure drop of 5kPa for accurate control.
8) Measure and control pressure imposed on the sub-circuits and as detailed on the Tender drawings.
9) Have a pressure range of 30-60kPa for Tender, confirm final requirement with Engineer prior to ordering of the valves.
10) Be supplied, installed and commissioned in accordance with the manufacturer's recommendations to achieve above requirements.
11) Be suitable for the system fluid, pressure, temperature and materials (as recommended by manufacturer) where this conflicts with above requirements clarify with Engineer.

Both the Engineer and the Commissioning Engineer shall review all differential pressure regulators and differential pressure commissioning valve selections. Valve selection information shall be scheduled, the schedule of information shall include:

1) Pressure drops for each valve.
2) Flow rate.
3) Size of valve.
4) Associated pipeline size.

This schedule shall be provided in sufficient time, minimum of 10 working days, for all comments to be returned and implemented prior to the commissioning valves being ordered.

2A-2-22 PRESSURE INDEPENDENT CONTROL VALVES

Pressure independent control valves consisting of differential pressure controller, and control valve shall be provided as indicated upon the Tender drawings and these shall:

1) Have valve body and material to suit systems operating below 120°C. Cast iron shall be an acceptable alternative on 65mm diameter and above.
2) Have a pressure rating to match system, subject to a minimum pressure rating of PN16 (or greater depending on media fluid).
3) Have a maximum port velocity of 2m/s.
4) Be designed and provided with integral flow verification metering stations however if metering stations are not integral to the control valves chosen then separate metering stations shall be supplied and installed to verify the actual flow rate of all pressure independent control valves.
5) Have a minimum available adjustment +/- 25% of design flow rate.
6) Maintain a valve authority in the range of 0.8 to 1.0 at all times.
7) Comply with the performance/ selection criteria stated elsewhere in this specification for the differential pressure component of the valve.
8) Have flow rate adjustment that shall:
   a) Not reduce the stroke of the control valve on valves of 50mm diameter and below.
   b) Not reduce the stroke by more than 30% on valves above 50mm diameter.
9) Be supplied, installed and commissioned in accordance with the manufacturer's recommendations to achieve above requirements.
10) Be suitable for the system fluid, pressure, temperature and materials (as recommended by manufacturer) where this conflicts with above requirements clarify with Engineer.

2A-2-23 FLOW LIMITING VALVES

Flow limiting valves shall be provided as indicated upon the Tender drawings, which shall:

1) Have a bronze body on systems operating below 120°C, cast iron shall be an acceptable alternative on 65mm diameter and above.
2) Have a minimum pressure rating of PN16 (or greater depending on media fluid).
3) Have a maximum port velocity 2m/s.
4) Have a maximum pressure drop of 20kPa.
5) Have a maximum control tolerance +/- 5%.
6) Have a minimum available adjustment +/- 25% of design flow rate.
7) Be suitable for the system fluid, pressure, temperature and materials (as recommended by manufacturer) where this conflicts with above requirements clarify with Engineer.
8) Have combined isolating and flow limiting valves with the replaceable cartridge type flow setting to limit maximum flow to the individual outlet on final domestic supplies to wash hand basins and the like.

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2A-2-24 SELF REGULATING TEMPERATURE VALVES

Self-regulating temperature valves shall be provided as indicated upon the Tender drawings, which shall:

1) Have a bronze body on systems operating below 120°C, cast iron shall be an acceptable alternative on 65mm diameter and above.
2) Have a minimum pressure rating of PN16 (or greater depending on media fluid).
3) Have a maximum port velocity 2m/s.
4) Have a minimum valve authority of 0.25.
5) Have a maximum pressure drop of 5kPa.
6) Have a maximum control tolerance +/- 5%.
7) Have a minimum available adjustment +/- 25% of design temperature, factory pre-set non-adjustable valves shall only be used where specifically allowed in writing by the Engineer.
8) Be suitable for the system fluid, pressure, temperature and materials (as recommended by manufacturer) where this conflicts with above requirements clarify with Engineer.

2A-2-25 DOMESTIC HOT WATER RETURN REGULATION

To enable domestic hot water return regulation, valves shall be provided whether shown on drawings or not to all of the following locations:

1) Spine mains.
2) Sub-branches.
3) Final branches.
4) Loops installed for future/ phased expansion.

Regulation shall be achieved as detailed in the specific sections of this specification and shall be by one of the following methods as directed in section M1 of this specification:

1) Double regulating valves which shall be:
   a) Installed on the return legs.
   b) Line size.
2) Dual function temperature limiting valves shall:
   a) Be installed in the returns of final branches and loops with commissioning stations installed in the return of spine mains and sub-branches.
   b) Have a primary thermostatic head, factory pre-set at temperature agreed in writing with Engineer, typically in the range of 57°C to 60°C.
   c) Have a secondary (pasteurisation) function factory pre-set at 70°C.
   d) Have both functions (normal operation and pasteurisation) to be adjustable on site for fine tuning during the commissioning process.
   e) Be complete with manufacturer's integral calibrated temperature gauge and proprietary insulation box cover which when fitted, still allows temperature to be read.
   f) Have performance and accuracy of temperature control in each mode, each valve shall be verified on site and recorded in manuals.

Any BMS temperature monitoring points shall be provided separate to these valves unless the selected valve has a tapping provided specifically for either a thermometer or temperature sensor and if so this may be used for the BMS temperature monitoring.

No other valve type (e.g. lock shield, gate, globe, butterfly etc.) shall be used for regulating purposes.

2A-2-26 AIR VENTS AND ELIMINATORS

Automatic Air Vents shall only be used at key points as agreed with the Engineer or shown on the Tender Drawings, where installed, they shall:

1) Be installed where indicated on the tender drawings.
2) Be as detailed in specific sections of this specification.
3) Be installed at all high points on all water systems to ensure complete venting where self-venting through the mains cannot take place or would not prove satisfactory.
4) Be complete with local isolation valve for maintenance purposes.
5) Be Spirotech Spirotop or engineer approved equal with the same 20 year warranty.
6) Be installed fully in accordance with manufacturer's recommendations such that guarantee is fully maintained.
7) Not be located in sections where they could allow air to be admitted during normal operation of the system.
8) Be clearly marked on 'as fitted' drawings showing accurate locations.
9) Have a minimum of a 50mm square branch (or line size if greater) with a 50mm diameter air bottle of a minimum length of 250mm.
10) Be complete with cap and 8mm brass needle type air cock or air valve where there is a risk of scalding.
11) Have 8mm diameter bleed pipe extended from the bottle where the air cock/ valve is fixed out of reach (e.g. steps/ scaffold, etc. would be required to gain access) which shall:
    a) Terminate in an air cock / valve 1.4m above finished floor level, ideally over a drain if possible.
    b) Have air cock / valve located in a convenient but unobtrusive location.

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c) Run in heavy quality mild steel tube with malleable iron fittings neatly run on the surface to a local drain where installed in voids, risers, plant rooms etc.

d) Not be installed where exposed to view in rooms unless unavoidable where it shall be installed in copper run within the thickness of a partition wall or in a wall chase. This shall only be adopted with written permission of the Engineer.

12) Be installed with a local isolation valve to allow vent replacement in the case of an automatic air vent, without needing to drain excessive quantities of system water.

In accordance with current British Standards, domestic hot and cold water systems shall avoid the use of air eliminators wherever possible, by using top connections to mains and venting via taps, where this is impossible air eliminators shall be used as a last resort and shall:

1) Be agreed with the Engineer prior to its use.
2) Be complete with check valve and isolation valve for maintenance purposes.
3) Be complete with a 15mm automatic air vent whose outlet shall be piped with an 8mm copper pipe to the nearest foul drain point.
4) Terminate via a tundish arrangement to a trapped waste or over a gulley suitable to accept pipework discharges without obstructing access for cleaning and rodding.

2A-2-27 THERMOMETERS, PRESSURE, ALTITUDE AND VACUUM GAUGES

All Gauges shall:

1) Be mounted with the diameter gauge in the vertical position.
2) Have a minimum diameter of 100mm.
3) Factory calibrated and individually certified in:
   a) Temperature: °C (between 2°C and 5°C per division)
   b) Pressure: Bar (gauge) or millibar.
   c) Altitude: metres head of water.
   d) Vacuum: millimetre Hg (gauge).
4) Have a black finished steel case and chromium plated bezel.
5) Have a black pointer and clear black lettering and scale on a white background.
6) Be fitted with a tamperproof loose red pointer that can be set on site to the working condition by removal of the front plate.
7) Be flangeless for direct mounted gauges.
8) Be either back or front flanged to suit either surface or flush mounted panel arrangements respectively for panel mounted pressure gauges.
9) Have either back or bottom entries to suit the mounting arrangements.
10) Carry the name of the manufacturer and shall all be of the same manufacturer and appearance as all other gauges used on the project.

Dial thermometers shall:

1) Have a suitable range for the service connected such that they can be accurately read, i.e. -40°C to +40°C on chilled or cold water, 0°C to 100°C on LTHW.
2) Be of the vapour pressure type with brass bulb.
3) Have a black finished steel case and chromium plated bezel.
4) Be flangeless for direct mounted gauges.
5) Be either black or front flanged to suit either surface or flush mounted panel arrangements. Capillary tube dial thermometers shall have plain bulbs with either loose pockets or flanges to suit the mounting arrangements for panel mounted dial thermometers.
6) Be visible and readable from ground level or permanent access platforms, i.e. no steps or access equipment needed to read gauges.

Pockets shall:

1) Be filled with heat conducting grease.
2) Be installed in a bend with the pocket facing into the fluid flow on domestic water systems.

Pressure, altitude and vacuum gauges shall:

1) Have a suitable range for the service connected such that they can be accurately read, i.e. 0 to 4 bars on a system with a working pressure of 1.5 bar.
2) Be of the bourdon gauge tube type with BSP male thread.
3) Be fitted with a bronze lever handle gauge cock with BSP female thread ends and a chromium plated finish.
4) Have a 'U' or ring siphon interposed between the gauge, cock and tapping point, where practical fitted adjacent to the latter.
5) Have a siphon on steam lines, formed from steel tube and shall be filled with water prior to the gauge being put into service.
6) Be visible and readable from ground level or permanent access platforms, i.e. no steps or access equipment needed to read gauges.

Capillary tubes shall:

1) Be of correct length (excess shall be no more than 300mm and shall be neatly coiled and fixed).
2) Have armoured flexible sheath.
3) Have radius bends not less than recommended by the manufacturer.

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4) Be routed for minimum risk of damage.
5) Be routed as agreed with the Engineer.
6) Be clipped to cable trays provided by the Contractor where cable trays are suitable containment.

2A-2-28 TEST POINTS

Test points, also called Binder Test Points and labelled on drawings as TP or BT, shall:

1) Be fitted in the following locations:
   a) Where indicated on the drawings.
   b) As detailed in specific sections of this specification (whether shown on drawings or not).
   c) Be installed before and after all:
      i) Pumps.
      ii) Strainers.
      iii) Non-return valves.
      iv) Heating, cooling and run around coils.
      v) Radiant panel, convectors and other emitters, except radiators.
      vi) Control devices such as control valves.
      vii) Plant items e.g. boilers, chillers etc.
      viii) DPR/DPCV/STAP/BPV valves – note also can be integral to valve assemblies if available.
2) Be of the binder type self-sealing test point with screw down cap.
3) Be extended spindle type to protrude above the thermal insulation.
4) Be PN 16 rated (or greater depending on media fluid).

Insulation shall be dressed around test points such that insulation, vapour seals and cladding are not compromised and access can be obtained without damage to finishes/ function. Extended stem type shall be used to all insulated services.

2A-2-29 WALL, FLOOR, ROOF AND CEILING PENETRATIONS

Where pipes penetrate through walls, floors, roof and ceilings, the penetrations shall:

1) Not restrict expansion/ contraction movement.
2) Where insulated services pass through a structure, the provision must accommodate the insulation unless omitted by detail.
3) At fire barriers, the fire integrity of the barrier must be maintained by converting the insulation to a non-combustible type, e.g. mineral wool, all suitably fire stopped. This comment relates to non-fire rated insulation such as phenolic insulation.
4) At fire barriers and structures, the thickness of insulation may be varied but care must be taken to prevent heat transfer sufficient to cause deterioration of the building fabric.
5) All services with a vapour barrier shall be arranged such that the vapour barrier is continuous through the wall / fire barrier by use of oversized sleeve or equivalent.
6) Where phenolic insulation must be installed then fire collars shall be installed over the insulation to maintain continuous vapour barrier and fire rating of the structure.
7) Maintain acoustic properties of the structure being penetrated, this shall be achieved either from detailed provided by an acoustic specialist or if no acoustic specialist employed by packing all air gaps with, suitably fire rated if required, flexible material such as Rockwool FirePro products.
8) Be provided a puddle flange on external walls.

2A-2-30 KEYS AND VALVE HANDLES

At the completion of the work, the following keys and valve handles shall be provided by the Contractor, who shall also obtain a receipt for the same:

1) 4 No. keys of each type and size for lock shield valves, panel doors, equipment access doors, etc., drain cock (each size) and 6 No. air cock keys.
2) External underground valve handles (2 No. per size installed) shall be provided.

2A-2-31 PAINTING AND IDENTIFICATION OF PIPEWORK, BRACKETS ETC

All pipework, including services not insulated, shall be:

1) Identified with colour bands as required by the latest British Standard.
2) Provided with the service description, pipe size and direction of flow.

Where colour identification on existing services are different to latest British Standards, the new services shall be referred to the Engineer for a decision on which standard shall apply.

All cut edges, supports, flanges, nuts and bolts and any other exposed metal shall be painted with one coat of 'Red Oxide' paint prior installation and a second coat applied after installation is complete. Where necessary, Red oxide paint to be heat resisting.

All exposed ferrous pipework, brackets and supports in boiler houses, plant rooms, tank rooms and external to buildings shall further be decoratively painted with two coats of an approved colour gloss paint, which shall be heat resisting where applicable (or hot dip galvanised after manufacture) as directed by the Engineer.

All plant and equipment with ferrous surfaces shall have at least two coats of protective paint applied at the manufacturer's works.

If manufacturer's finishes are damaged on site, these shall be repaired or replaced to an 'as new' condition to the satisfaction of the Engineer and the manufacturer who shall confirm that warranties shall not be affected.

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2A-2-32 CHROMIUM PLATING

All hot and cold water pipes, valves, fittings and pipe clips, where exposed for short runs only in toilet, kitchen, food preparation, shower, bathroom and sluice areas shall be chromium plated unless stated otherwise in the Particular Clauses later in this Specification. Exposed and uninsulated pipework shall be minimised as far as absolutely practical and must be in accordance with current industry standards.

2A-2-33 EQUIPOTENTIAL BONDING

The main incoming piped services shall be bonded by the site electrician as close to the point of entry as possible, all subsequent bonding and cross bonding shall be completed by the Contractor.

2A-2-34 FIRE STOPPING

All pipework passing through fire barriers or cavity barriers shall be fire stopped by the Mechanical Contractor. All fire stopping shall be of appropriately rated material so as not to compromise the fire barrier integrity. The fire stopping systems shall be manufactured and installed by Promat Ltd or equal and approved. The fire barriers shall not compromise any vapour seals.

Each fire stopped position shall be provided with a signed and dated approved installer label. This label shall signify that the fire stopping has been installed to the manufacturer's requirements.

2A-3 COMMON REQUIREMENTS FOR VARIOUS SYSTEM TYPES

2A-3-1 STEEL PIPEWORK

Steel pipework shall be installed as detailed in the BESA TR20 Guide relevant to the service being installed, subject to the following additional requirements/amendments.

Mild steel pipework shall:

1) Be low carbon heavy grade pipe (red band).
2) Mild steel press fit systems are not permitted.
3) Be supplied with standard works anti-corrosive lacquer finish.
4) Be stainless steel on overflows, vents and drains (or alternatively copper).
5) Have a minimum pipe size of 15mm diameter on any part of the circulating system.
6) Jointing shall be:
    a) Threaded connections on LTHW and CHW pipework with a working pressure less than or equal to 7 bar (gauge) for 50mm diameter pipework and below.
    b) Threaded connections on 65mm pipework shall only be used where this does not compromise the system in terms of the required working / test pressure and operating temperature and only if stated as permitted in the particular clauses of this specification or on the tender drawings.
    c) Welded connections in all other cases.
    d) Joints in inaccessible locations shall be avoided. Should this not be possible, written permission shall be obtained from the Engineer and welded joints employed.
7) All pipework within non-accessible voids and ceiling spaces shall be of fully welded construction. Note – removable suspended ceiling tiles are classified as accessible voids but services above plasterboard or non-removable ceilings are classified as non-accessible voids.
8) Blank ends shall be formed using welded cap ends on pipework 32mm diameter and below, flanges shall be used in all other cases.
9) All branches shall be formed utilising proprietary fittings, branches welded in square or welded shoes shall not be used.
10) All threads shall be taper type, parallel shall only be used to match control valves and the like where taper threads are not available.

2A-3-2 WELDING

1) Acceptable Welding Certificates for all steel pipes:
    a) Steam pipework – Class I welding to BS listed in 'General Standards Applicable'.
    b) All services with a normal operating pressure above 16bar(g) class I welding to BS listed in 'General Standards Applicable'.
    c) Hospital/ Health Projects, all services apart from steam – Class II welding to BS listed in 'General Standards Applicable'.
    d) All services elsewhere up to 16bar(g) and within the temperature range -20°C to +220°C shall be to one of the following:
        i) Class I welding to BS listed in 'General Standards Applicable'.
        ii) Class II welding to BS listed in 'General Standards Applicable'.
        iii) BESA TR/5 'Welding of carbon steel pipework' compliant and fully certificated welder who holds a current 'SKILLcard' for the welding class and type being undertaken.
2) Supervision/ Quality Control:
    a) The Contractor shall ensure that the standard of workmanship is fully in accordance with the standards set out in the specified welding standard/ certificate.
    b) The welder's individual mark shall be stamped adjacent to each weld.
    c) A copy of the certificate, individual mark and date of issue shall be issued to the Engineer for each welder employed on the project prior to each welder commencing work on site, copies shall also be included in the O&M manuals.

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d) Any weld without an individual mark shall be tested by non-destructive testing, then marked by BESA inspector (or cut out and remade) all at Contractor's own expense.

3) Non-Destructive Testing shall:

a) Be completed outside normal working hours or when site/ area is unoccupied for health and safety reasons.

b) Be completed by an independent BESA / Insurance approved inspector to the standard matching the specified welding certificate.

c) Be radiographic/ ultrasonic as suitable, to be determined by inspector.

d) The decision of the inspector shall be binding on the Contractor at no additional cost to the contract.

e) The following levels of testing shall be included for at tender stage and carried out during the installation:

SERVICE	PERCENTAGE TESTED
All buried pipes	100%
Low Temperature Hot Water (LTHW)	5%
Domestic Hot Water Services (DHWS)	5%
Domestic Cold Water Services (DCWS)	5%
All other services	100%

4) Any production welds that fail the test shall be repaired/ replaced and a further 5% of welds tested, further failures shall require 100% of welder's work to be tested and made good all at Contractor's own expense.

5) Welding particulars:

a) Building protection using appropriate materials shall be provided to prevent scorching and fire damage.

b) Where electric welding is employed, the Employer's supply shall not be used, either temporary power or suitable (power/ noise/ emissions) generator provided.

2A-3-3 VICTAULIC GROOVED PIPEWORK AND FITTINGS

Where Victaulic grooved pipework systems have been specified, the following shall apply to the installation:

1) Victaulic as a term when used within this specification applies to 'Victaulic Company' products and not a generic term for other grooved systems. Other grooved systems are not permitted.

2) All references to 'Victaulic' detailed in this specification and on all tender drawings applies to the 'Victaulic Mild Carbon Heavy Steel System' and not any other systems offered or available.

3) All pipework used with Victaulic couplers, fittings and valves shall be cut or roll grooved fully in accordance with the 'Victaulic Standard Groove Specification' submittal documents.

4) Only 'carbon steel pipe – grooved valves' shall be permitted and shall be fully as per other clauses of this specification in terms of valves seat materials, extended stems for insulation, construction materials, etc.

5) The entire installation shall adhere strictly to the manufacturers 'best practice' guidelines and recommendations including but not limited to 'Victaulic Installation Procedures – Quality Controls and Quality Assurance Standards'.

6) Be fully compatible with the fluid temperatures and pressures of the systems.

7) Only roll grooving machines manufactured by Victaulic shall be used on the project.

8) All installation personnel shall be fully trained by Victaulic in the correct and safe use and installation of their products. Signed and dated proof of training shall be provided for all installation staff prior to commencing any installation.

9) Regular site inspections shall be carried out by Victaulic personnel and all these visits shall be documented and recorded by both the Victaulic personnel in the form of their 'Job Walk Reports' and by the mechanical contractor as part of the installation. All observations and recommendations made by the Victaulic personnel during their site visits shall be adopted and incorporated in the installation to ensure the complete installation is compliant with their recommendations prior to the system be pressured tested or flushed.

10) All documentation recommended in the 'Victaulic Installation Procedures – Quality Controls and Quality Assurance Standards' shall be incorporated into the O&M manuals.

2A-3-4 COPPER PIPEWORK

Copper pipework shall be installed as detailed in the BESA TR20 guide relevant to the service being installed, subject to the following additional requirements/amendments.

Copper pipework shall:

1) Be chromium plated after mock up assembly when exposed to view in toilets/ tea points, kitchen, etc.

2) Have a minimum pipe size of 15mm diameter on any part of the circulating system.

3) Jointing shall be:

a) Soft solder on pipework up to and including 54mm diameter that are within the temperature/ pressure limitations for the solder/ fitting.

b) Brazed on pipework 67mm diameter and above, as well as all sizes of condensate (steam systems) services.

c) Compression fittings on final connection to equipment and valves where no alternative is available (i.e. ball-o-fix valves) excluding steam condensate systems (where no compression joints are permitted).

4) Joints in inaccessible locations shall be avoided. Should this not be possible, written permission shall be obtained from the Engineer and brazed joints employed.

5) SOFT SOLDER JOINTS - Lead free solders shall be used.

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2A-3-5 BRAZED JOINTS

Brazing shall be used for the following copper pipe installations:

1) Water services and chilled water copper pipework 67mm diameter and above.
2) All gravity and pumped (steam) condensate services.
3) All inaccessible copper pipework (e.g. concealed in partitions, etc.)

All brazing shall:

1) Be completed by suitably qualified and experienced fitter who has current certification to demonstrate competence for the particular works being undertaken. Copies of certificates shall be provided prior to works commencing.
2) Bronze brazing shall not be used without the written permission of the Engineer due to the risk of dezincification.
3) Silver brazing shall be used unless agreed otherwise in writing with the Engineer.
4) Fittings shall be Pegler Yorkshire General High Duty fittings. All of which shall be BSI Kite Mark stamped and WRAS approved.
5) Supervision/ Quality Control:
   a) The Contractor shall ensure that the standard of workmanship is fully in accordance with the standards set out in the specified brazing standard/ certificate.
   b) The blazer's individual mark shall be stamped adjacent to each joint.
   c) A copy of the certificate, individual mark and date of issue shall be issued to the Engineer for each pipe fitter who carries out any brazing work on the project prior to each fitter commencing work on site. Copies of all certificates shall also be included in the O&M manuals.
   d) Any joint without an individual mark shall be tested by non-destructive testing, then marked by BESA inspector (or cut out and remade) all at Contractor's own expense.
6) Non-Destructive Testing shall:
   a) Be completed outside normal working hours or when site/area is unoccupied for health and safety reasons.
   b) Be completed by an independent BESA /Insurance approved inspector to the standard matching the specified brazing certificate.
   c) Be radiographic/ ultrasonic as suitable, determined by inspector.
   d) The decision of the inspector shall be binding on the Contractor at no additional cost to the contract.
   e) The following levels of testing shall be included for at tender stage and carried out during the installation:

SERVICE	PERCENTAGE TESTED
All buried pipes	100%
Low Temperature Hot Water (LTHW)	5%
Domestic Hot Water Services (DHWS)	5%
Domestic Cold Water Services (DCWS)	5%
All other services	100%

   f) Any production brazed joint which fails the tests shall be repaired/ replaced and a further 5% of brazed joints tested, further failures shall require 100% of blazer's work to be tested and made good all at Contractor's own expense.
7) Brazing particulars:
   a) Building protection using appropriate materials shall be provided to prevent scorching and fire damage.

2A-3-6 MAPRESS & XPRESS SYSTEMS

This shall apply to the following systems:

1) Geberit Mapress copper.
2) Geberit Mapress stainless steel.
3) Pegler Yorkshire XPress copper.
4) Pegler Yorkshire XPress stainless steel.

When using above systems the Contractor shall:

1) The manufacturer's proprietary system components shall be used along with approved components such that the full manufacturer's warranty is fully maintained. (e.g. Yorkshire Xpress shall only be used with Yorkshire pipework).
2) Not be used for final connection to plant / equipment, except connections to sanitary ware.
3) Be installed fully in accordance with manufacturer's written instructions.
4) Take into account of the increased requirements for expansion/ contraction using natural flexibility.
5) Be of a minimum pressure rating of PN16.
6) When offered as an alternative the system resistance shall not be increased, Contractor shall include for increased pipe sizes as necessary.
7) Ensure that the following is included for and provided by the manufacturer:
   a) All fitters to have attended manufacturer's training course and have appropriate current certification.
   b) Site progress inspections with written inspection reports and details of corrective action/ comments to be completed by manufacturer own Engineers.

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c) Site completion inspections with written inspection report and details of corrective action/ comments to be completed by manufacturer own Engineers.

d) 25 year installation and materials warranty provided by manufacturer, project specific certificate to be provided.

8) Offsite fabrication shall be employed to the maximum extent, on site jointing shall be the minimum necessary to connect prefabricated sections.

9) Each joint shall be marked with the fitter's individual symbol/ initials (after joint has been crimped) corresponding with a key included in the O&M manuals to allow quality monitoring of jointing process and visual check that joint has been crimped. Any joints not permanently marked shall be cut out and replaced.

10) Manufacturer's storage recommendations shall be meticulously complied with due to increased susceptibility of these systems.

11) In areas of high humidity, externally and wherever moisture may be in contact with the system (e.g. chilled water, etc.), the manufacturer's recommendations with regard to additional corrosion protection such as anti-corrosion tape to fittings shall be complied with in full.

12) Condition of specialist jointing tools and jaws / terminals, etc. shall be continuously monitored and replaced in accordance with manufacturer's recommendations.

13) Only manufacturers own seals / "O" rings, etc. shall be used, where a choice of material is offered, this shall be selected to give the maximum life for the system as a whole (e.g. Butyl rubber rather than PTFE).

14) Connections to valves and equipment shall be completed in accordance with the fitting/ pipework manufacturer's recommendations using preparatory fittings wherever they are available.

15) When installed in confined spaces and voids the manufacturer's minimum recommended spacing around the services shall be provided to enable future connections and repairs to be undertaken without removing adjacent services, etc.

16) Supports for the pipework system shall:

a) Be the manufacturer's purpose designed support system incorporating pipe carriers.

b) Be suitable for the expansion/ contraction system employed.

c) Prevent stress on joints, particularly when connecting to risers & equipment.

2A-3-7 PLASTIC PIPEWORK SYSTEMS

This shall apply to the following systems:

1) George Fisher Instaflex

2) Polyethylene systems.

3) Protected polyethylene systems.

4) ABS system.

When using above systems, the Contractor shall:

1) Use the manufacturer's proprietary system components along with approved components such that the full manufacturer's warranty is fully maintained. (e.g. George Fisher Instaflex shall only be used with Instaflex pipework).

2) Not to be used within plant rooms.

3) Not be used for final connection to plant / equipment.

4) Not be used where exposed to view.

5) Be installed fully in accordance with manufacturer's written instructions.

6) Take into account of the increased requirements for expansion / contraction using natural flexibility.

7) Be of a minimum pressure rating of PN16.

8) Ensure that the following is included for and provided by the manufacturer:

a) All fitters to have attended manufacturer's training course and have appropriate current certification.

b) Site progress inspections with written inspection reports and details of corrective action / comments to be completed by manufacturer own engineers (George Fisher only).

c) Site completion inspections with written inspection report and details of corrective action / comments to be completed by manufacturer own engineers (George Fisher only).

d) 12 year installation and materials warranty provided by manufacturer, project specific certificate to be provided (George Fisher only).

9) **Any installation concerns raised by Contract Administrator shall be addressed by the manufacturer's technical representatives attending site to inspect the installation and then provide a definite written statement on the installation being fully in accordance with the manufacturer's best practice recommendations and if not deemed to be in accordance the installation shall be rectified at no cost to the contract to be fully in accordance with the manufacturer's recommendations. The Engineer shall be invited to attend site for this manufacturer's inspection.**

10) Maximum off site fabrication and on site jointing shall be the minimum necessary to connect prefabricated sections.

11) Employ the following jointing techniques:

a) On site shall be electro fusion using manufacturer's proprietary fittings and automatic heating and control unit.

b) Off site in manufacturer's works shall be electro fusion, butt or socket fusion process.

c) Each joint shall be recorded by the operator/ fitter and included in the O&M manuals to allow quality monitoring of jointing process. Any joints not properly recorded shall be cut out and replaced.

12) Manufacturer's storage recommendations shall be meticulously complied with due to increased susceptibility of these systems.

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13) Condition of specialist jointing tools and jaws/ terminals, etc. shall be continuously monitored and replaced in accordance with manufacturer's recommendations.

14) Connections to valves and equipment shall be completed in accordance with the fitting/ pipework manufacturer's recommendations using preparatory fittings wherever they are available.

15) When installed in confined spaces and voids, the manufacturer's minimum recommended spacing around the services shall be provided to enable future connections and repairs to be undertaken without removing adjacent services, etc.

16) Supports for the pipework system shall:

a) Be the manufacturer's purpose designed support system incorporating pipe carriers (alternatives such as cable tray / basket, etc. shall not be accepted).

b) Be suitable for the expansion/ contraction system employed.

c) Prevent stress on joints, particularly when connecting to risers & equipment.

d) Be provided with brackets at support centres recommended by the manufacturer.

17) Where pipework is supplied pre-insulated with Armaflex insulation, this shall then be supplemented with insulation / covering such that an equivalent thermal performance, physical surface protection and spread of flame rating is provided as that detailed in the thermal insulation section of this specification.

2A-4 AMENDMENTS TO BESA TR SERIES DOCUMENTS

2A-4-1 GENERAL

This Section of the Specification details the unique requirements associated with each system type. The BESA pipework guides are used as the basic requirements with any clarifications/ alterations/ additional requirements set out within this Section of the Specification.

Where the term "should", "may" "preferably" or "will" is used within the documents, the procedure shall be fully complied with, and included for at tender stage, any deviation from these standards shall only be permitted in exceptional circumstances and with the written permission of the Engineer obtained beforehand.

Where any discrepancy is found between the BESA documents and this Specification, the issue shall be raised and agreed prior to tender submission, where clarification is not obtained prior to tender the most onerous condition shall be included.

General requirements detailed earlier within this Specification show clarifications/ alterations/ additional requirements that are applicable to all of the BESA guides.

2A-4-2 AMENDMENTS

1) Table defining support intervals shall not be applied, refer to an earlier clause of this specification for requirements.

2) Main earth bonding to services at entry point to building shall be provided by the Contractor.

3) Where items are detailed in the specific sections or within this section of the specification, they shall be complied with over and above the requirements in the BESA documents.

4) On variable volume systems, regulation/ balancing shall be provided in accordance with this specification in addition to any pressure differential valves, etc.

5) For thermal insulation, refer to thermal insulation section of this specification and the current building regulations.

6) For testing, flushing, cleaning and water treatment, refer to requirements detailed later in this section of the specification.

7) Identification shall be in accordance with the BESA documents with the additional requirements set out in this specification.

2A-5 PRESSURE TESTING / PURGING

2A-5-1 PRESSURE TESTING

The Contractor shall pressure/ leak test all systems to the following standards:

1) Produce and issue for comment a method statement for pressure/ leak testing which shall:

a) Be fully in accordance with HSE guidance document (Refer to standards at the beginning of this section).

b) State pressure, test duration and testing fluid for each service being tested.

c) Provide a programme for the testing works with dates for witnessing.

d) Confirm that proposed pressures are within the manufacturer's maximum pressures for the material used.

e) Address each of the requirements detailed in this section of the specification.

f) Incorporate any comments made by Engineer, etc.

2) Pressure / leak tests shall be completed prior to joints being covered / painted to allow a full visual inspection for evidence of leaks.

3) System pressure shall be monitored by calibrated pressure gauges installed at the closest and furthest points from where pressure is introduced. Where distance from highest to lowest point exceeds 15m, gauges shall also be fitted at the highest and lowest point of the system.

4) Pre-commissioning shall commence within 48 hours of pressure test to prevent contamination due to untreated water/ water residue remaining in system, where this cannot be achieved either treat water with inhibitor/ biocide or drain down and fully dry system (hot air drying) all as recommended in BSRIA guides.

5) Where pressure test fails, the fault / leak(s) shall be located and repaired and then the pressure tests undertaken again, this process shall continue (at Contractor's own expense) until a successful test is achieved and witnessed.

6) Systems shall be pressure tested in accordance with the 'Minimum Requirements for Pressure Testing' detailed below.

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MINIMUM REQUIREMENTS FOR PRESSURE TESTING				
Systems shall be pressure tested to whichever is the greater of the following 3 requirements: a) Minimum pressures detailed in this table or, b) As detailed in the particular specification sections or, c) 1.5 times working pressure if greater than those tabulated below.				
SERVICE	MATERIAL	TEST PRESSURE	TIME	NOTES
LTHW Heating, Chilled Water	Steel / Copper	5 bar(g)	4 hrs	
	Plastic	5 bar(g)	4 hrs	Allow for additional expansion of pipe
Domestic Services	S/S & Copper	7 bar(g)	4 hrs	
	Plastic	5 bar(g)	4 hrs	Allow for additional expansion of pipe
Domestic Services, below ground	S/S & Copper	7 bar(g)	4 hrs	
	Plastic	5 bar(g)	4 hrs	Allow for additional expansion of pipe
All domestic water subject to pressure from utility mains above & below ground	S/S & Copper	14 bar(g)	4 hrs	
	Plastic	14 bar(g)	4 hrs	Allow for additional expansion of pipe
Open Vents	Copper	5 bar(g)	4 hrs	
Drains	All	0.7 bar(g)	4 hrs	
	Specialist	1.5 bar(g)	4 hrs	Laboratories, contaminated waste, etc.
Fire mains, dry risers etc.	All	15 bar(g)	4 hrs	

All pressure testing shall incorporate the following:

a) Specialist plant and portions of the works, which cannot be exposed to the main system test pressure shall be tested separately in sections/ phases as required.

b) Where specialist pipework systems are employed (e.g. Geberit Mapress, Pegler Yorkshire Xpress Fit and Instaflex), manufacturer's requirements shall be adhered to, any conflict shall be brought to the attention of the Engineer.

c) Where materials expand under pressure (i.e. plastic pipework), provide calculations to demonstrate permissible pressure loss during test period.

d) Local authority shall be consulted to confirm pressures meet their minimum requirements (gas, water, etc.).

2A-6 PREPARATION OF SYSTEM FOR COMMISSIONING

The term "pre-commission" is used throughout this section of the specification to mean the flushing, chemical cleaning and dosing of the system.

Where the guides state typical practice, this shall be taken as being required unless particular circumstances allow/ require an alternative approach, the Contractor shall include for the most onerous solution in all cases and only deviate from typical practice when written acceptance of the Engineer is obtained.

Where the guide advocates strainers at all terminal devices, etc., this has not been provided due to the level of increased energy consumption and maintenance required, the Contractor shall therefore ensure that the pre-commissioning of the system is completed to the highest possible standard such that these secondary strainers are not required.

2A-6-1 SPECIALIST CONTRACTOR

Except for a small number of cases detailed below, the pre-commissioning of all water systems shall be completed by a Specialist Contractor employed by the Contractor.

The Contractor shall employ one of the following specialists to complete the pre-commissioning, flushing and domestic water services sterilisation works detailed later in this specification section:

WATER TREATMENT SPECIALISTS			
COMPANY NAME	TEL. NO.	EMAIL ADDRESS	LOCATED
Airtech Commissioning Limited	0121 4154141	heather.underhill@airtechcomm.co.uk	Birmingham
Aston Environmental	01789 400 013	enquiries@astonenvironmental.co.uk	Alcester
Cardiff Commissioning Limited	029 2052 1111	cardiffcomm@cix.co.uk	Cardiff
GES Leicester Limited	0116 277694	ges.limited@btconnect.com	Leicester
Goodwater Limited	0118 973 5003	info@goodwater.co.uk	Wokingham
Kebble Environmental Services	01279 417 878	enquiries@kesltd.co.uk	Harlow
MSM Environmental Services	01527 852344	admin@msmenvironmental.co.uk	Stratford Upon Avon / Bury
MWS (UK) Limited	01204 676 370	info@mws-ltd.co.uk	Bolton / Essex
PH Water and Air Technologies	01252 543668	www.phwatertechnologies.co.uk	Farnborough
Richmond Hydrochem Special Projects	024 7666 6482	info@richmondhydrochem.co.uk	Coventry

The cases where the pre-commissioning does not need to be completed by a Specialist are:

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1) Minor modification to system where draining down occurs locally and involves the removal / replacement of less than 100 litres of system water. (e.g. relocating a radiator).

2) Replacement of a component of a new / existing system where draining down occurs locally and involves the removal / replacement of less than 100 litres of system water.

In those cases where a Cleaning Specialist is not required, the Contractor shall undertake the works detailed in this section of the specification with the following modifications:

1) Drained section of system shall be pre-commissioned before opening up to the main system.

2) Any inhibitor used shall be compatible with that used in the main system, where the inhibitors in the main system are not known, a sample shall be taken and analysed by a Water Treatment Specialist and their advice followed with regard to cleaning and dosing methods employed.

3) The existing main system water shall not be used for pre-commission or filling the section of the system being worked upon, either dedicated temporary pumps or mains water shall be used.

4) Upon completion of the works, a sample of the water shall be taken immediately prior to opening up the section to the main system and a laboratory analysis performed to ensure the overall system inhibitor protection measures are maintained; the results are to be included in the O&M documentation.

2A-6-2 SYSTEM REVIEW AND METHOD STATEMENTS

Prior to submitting Tender, a Water Treatment Specialist shall be consulted to ensure that the requirement and costs for temporary pumps, water supplies, tanks etc. are included at Tender stage to allow the systems to be adequately pre-commissioned.

The requirements for pre-commissioning of the systems shall be reviewed in detail and agreed at an early stage in the project before installation works commence.

All pre-commissioning works shall be completed in accordance with the BSRIA pre-commissioning documents, refer to standards at the beginning of this section and incorporating the requirements set out within this specification.

The initial review of the system shall:

1) Confirm the quality of the available water supply for initial fill is suitable as detailed in BSRIA standards and also water in all systems always contains sufficient biocides and inhibitors at all times and not just on completion of works.

2) Ensure that sufficient facilities have been included to allow the system to be pre-commissioned in accordance with the guidance, checking for adequacy of flushing points, bypasses, etc.

3) Determine the method of circulating water to achieve required capture velocities. If system pumps are to be used, the Contractor shall ensure that the manufacturer's warranty is not affected in any way. Temporary pumps shall be used where the system pumps are not suitable.

4) Determine how flushing velocities can be achieved. Low energy design practice is tending to reduce operating velocities thereby, reducing the likelihood that system pumps will be capable of achieving required flushing velocities.

5) Consider materials used throughout the system (Note: aluminium heat exchangers are becoming far more prevalent).

6) Consider specialist pipework systems being employed (e.g. Geberit Mapress, Pegler Yorkshire Xpress Fit, and Instaflex) where manufacturer's particular requirements shall be incorporated, and any conflict shall be brought to the attention of the Engineer.

7) Consider methods of construction and likely level of contamination (i.e. welding method employed, use of plastic or mechanical jointing to minimise contamination, working practice, etc.)

8) Ensure sufficient information has been obtained from the Designer to allow pre-commissioning to be completed.

9) Availability of drains, necessity of using temporary tanks, etc.

A method statement shall be provided to detail the pre-commissioning process for each system or part thereof, in addition to the conclusions of the initial review, the following shall be addressed and provided within the statement:

1) A schedule of the pre-commissioning stages to be undertaken.

2) Details of all chemicals to be used during the pre-commissioning and reasoning for the selection of the same.

3) A programme for the pre-commissioning works along with dates for witnessing.

4) Method of water circulation to be employed.

5) Confirmation from local water authority that chemical discharge is accepted along with a copy of the temporary license obtained if necessary (Liaison and obtaining temporary license shall be the responsibility of the specialist); where approval cannot be obtained in sufficient time, an alternative disposal method shall be employed that meets current regulations at no additional cost.

6) Marked up drawings to indicate each flushing circuit and process with minimum velocities to be achieved.

7) Details of any temporary plant and equipment to be used along with temporary power supplies/ generators as appropriate.

8) Laboratory results and recommendations of water samples taken prior to pressure testing and if system maintained full for more than 2 weeks, prior to flushing.

9) All necessary health and safety information, risk assessments and COSHH information.

The method statement shall be submitted and reviewed along with any comments incorporated prior to commencement of pre-commissioning works.

2A-6-3 CHEMICAL CLEANING

Chemical cleaning of the system shall:

1) Be completed in accordance with the described guides and method statements.

2) Continue until satisfactory cleanliness is achieved as defined in the described guides.

3) Be witnessed by the Clerk of Works or Commissioning Specialist.

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4) Recorded by the Tenderer and certified by the Clerk of Works or Commissioning Specialist.

5) Be completed in the absence of any filters, meters, circulating pumps, traps, valves, controllers, non-return valves and items of equipment which may be damaged or prevent adequate flushing, all of which shall be removed during the flushing process by the Contractor and re-instated upon completion.

2A-6-4 SYSTEM ADDITIVES

Based upon the laboratory results described above and system particulars the appropriated inhibitors, biocides, antifreeze, etc. shall be introduced into the system via a dosing pot or combined pressurisation and dosing tank system.

System additives shall be introduced, via a dosing pot, which shall:

1) Be adequately sized for the system (10 Litres minimum).

2) Be a proprietary pre-fabricated unit with fill funnel, check valve, drain and service valves that shall be positioned in a location agreed by the Engineer.

3) A fill tundish level that allows operatives to safely lift and poor water treatment chemicals.

4) Be provided whether indicated on drawings or not, assuming a distance of 5 metres from its system connection point.

A permanent laminated label shall be fixed adjacent to the dosing pot stating date/quantity/% of system volume used in initial treatment.

The Contractor shall monitor the effectiveness of the additives during initial operation and take all necessary action to ensure that system has sufficient treatment during the initial operation, all at Contractor's own expense.

The effectiveness of system additives shall be checked at the following intervals:

1) 7 days after system is made operational.

2) 3 Months after practical completion.

3) Immediately prior to the end of defects period.

Each system check shall include the following:

1) Samples shall be taken from representative points in each system to ensure that the treatment has been successful.

2) An analysis of these samples shall be undertaken by an Independent UKAS accredited laboratory.

3) If treatment levels are below recommended levels then additive level shall be topped up as necessary.

4) If treatment levels have dropped below expected levels for normal system operation (i.e. leak or excessive top up with fresh water is occurring), the system shall be inspected and cause identified and repaired before additives are topped up as appropriate, a report shall be provided detailing cause and corrective actions, chemicals added and recommendations for further monitoring.

5) Should alteration, draining down and refilling of system by Client's maintenance personnel be identified as the cause of low water treatment levels, the Contractor shall immediately inform the Client (in writing) of any corrective action that needs to be undertaken to return the system to recommended levels.

The Contractor's O&M documentation shall clearly identify the necessity of monitoring and maintaining system water treatment levels in order to prevent system corrosion and not invalidating manufacturers' guarantees/ warranties.

Any failure of pipework/ equipment occurring due to non-compliance with the above shall be replaced at the Contractor's own expense.

2A-6-5 DE-AERATION

Removal of air from the system is an on-going process that shall be continued by the Contractor until all air has been removed.

The de-aeration process shall be undertaken at the following times:

1) On a continuous basis during the system fill period and for at least 4 hours thereafter.

2) Immediately prior to commencement of commissioning and on a daily basis during commissioning.

3) Twice a day for the first 7 days after the system has been filled.

4) On a weekly basis until no air is released for two consecutive weeks.

Where automatic air vents and air separators are employed these shall be checked on a daily basis for correct operation and any signs of leakage of water.

2A-6-6 TRACE HEATING

All external water pipework, including vent and drain lines shall be fully trace heated prior to insulation. The trace heating shall be of the self-regulating type.

The trace heating shall be completed with all necessary junction boxes, fixing tape, warning labels and seals for a complete installation and shall be interfaced with the BMS.

The system shall be installed as follows:

1) One circuit for flow and one for return joined in parallel by a suitable junction box, which shall then connect back to a power supply point.

2) Installed spirally around each pipe to give an output sufficient to prevent pipework from freezing.

3) Adequately wrapped around exposed items such as valves, etc.

4) Provided with correct installation items including entry boxes.

5) Self-regulating to maintain pipe at 4°C at a design ambient of –20°C.

6) Installation shall be Raychem Ltd, their H-watt system or equal and approved.

7) Entire installation shall be fully in accordance with manufacturer's best practice recommendations.

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2A-7 POST CLEANING AND STERILISATION

2A-7-1 FLUSHING AND SAMPLES

Where flushing loops are not indicated on the design drawings, the Contractor shall include for either temporary disconnection and installation flushing hoses or a permanent flushing bypass complete with isolating valve, this shall be provided at no additional cost to the contract.

Flushing and sampling of all systems shall:

1) Be completed in accordance with the described guides and method statements, specifically including but not limited to BSRIA BG29 and BS 8552 for methodology and frequency of both.
2) Continue until satisfactory cleanliness is achieved as defined in the described guides.
3) Be witnessed by the Clerk of Works or Commissioning Specialist.
4) Recorded by the Tenderer and certified by the Clerk of Works or Commissioning Specialist.
5) Be completed in the absence of any filters, meters, circulating pumps, traps, valves, controllers, non-return valves and items of equipment which may be damaged or prevent adequate flushing, all of which shall be removed during the flushing process by the Contractor and re-instated upon completion.

Samples shall be taken 7 days after treatment from representative points in each system to ensure that the treatment has been successful and shall be carried out fully in accordance with the previously listed standards.

An analysis of these samples shall be undertaken by an Independent UKAS accredited laboratory at the Contractor's expense. The fully satisfactory and compliant results, compliant with above quoted standards, shall be provided within the Operating and Maintenance Manuals. Non-satisfactory or non-compliant results shall be repeated after any necessary remedial works, all remedial works and retesting shall be at the contractor's expense.

No system shall be left charged with untreated water for a period in excess of 48 hours, where this period is exceeded, the BSRIA recommendations with regard to biocides and cleansing, etc. shall be followed in full at the Contractor's own expense.

If treatment process proves unsuccessful, the Engineer shall instruct for repeat treatment at the Contractor's expense.

It may not be practical to achieve sufficient flushing velocities through low loss headers, thermal stores, etc. so these must be kept clean by a combination of:

1) The use of flushing bypasses so that suspended solids do not enter these components.
2) Removable ends on vertical low loss headers complete with bolted blanking plates. Horizontal low loss headers are not permitted.
3) Provision of multiple inspection chambers to allow visual physical inspection of internal surfaces and prove internal cleanliness of all vessels. Dated digital images of the internal condition of all vessels shall be included within the operating and maintenance manuals.

2A-7-2 DOMESTIC WATER SERVICES STERILISATION

On all projects, the Contractor shall:

1) Fill, pressure test and flush the system using water from an appropriate source for example:
   a) Mains water supply.
   b) Temporary site supply.
   c) Potable drinking water bowser.
2) Sterilise the complete system including pipework, tanks, etc. in accordance with the British Standard defined in the standards section of this specification.
3) HTM requirements shall also be adhered to on all healthcare and related projects.
4) The Engineer shall be notified 48 hours prior to sterilisation taking place so that arrangements can be made to witness the procedures.

   Provide and maintain safety labels and signs in accordance with the British Standard and as follows:
   a) Warning signs at every outlet during chlorination process.
   b) Warning signs at principle drinking water points and common area such as site canteen, office and entrance stating water on site is not suitable for drinking, these signs to be maintained until satisfactory laboratory results are obtained.
5) After completion of the sterilisation, maintain the service in safe condition by regular flushing out of the systems, until the date of Practical Completion (twice weekly flushing routine for entire system including hose reels, etc. formally recorded and witnessed by the Clerk of Works or the Commissioning Specialist). Calculate the water capacity of the various sections of the systems and the amount water to be drawn off to ensure that completely fresh mains water is drawn into the system twice weekly.
6) Should twice weekly flushing not be adequately completed, the system shall be re-chlorinated and sample taken/ analysed.
7) Provide certification showing the areas/ sections treated, the levels of chorine solution used.
8) Take samples between 2 and 7 days after completion of sterilisation, note this delay is mandatory so samples shall not be taken the same day as sterilisation is completed and obtain laboratory analysis which shall:
   a) Be taken at representative locations throughout each system as follows:
      i) Incoming mains supply.
      ii) Sentinel point on each system (e.g. DHW, MCW, BTCW, etc.).
      iii) Each storage tank (where fitted).
      iv) In agreed locations throughout the remainder of the systems at the rate of one sample per 20 outlets (or pair of outlets where serving WHB or the like).

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b) Be analysed by a UKAS accredited laboratory in accordance with British Standards and Public Health Laboratory Recommendations.

c) Include an 'E' Coli, total viable count (TVC) at both 22ºC and 37ºC, Coliform bacteria, chemical analysis, copper content, lead content, Pseudomonas aeruginosa, disinfection residuals and legionella test.

d) Analysis of results and clear statement with regard to suitability for human consumption.

e) Early issue of results (before legionella results are available) where required by local authority in order to connect the new mains water supply.

9) In the event of any of the test results not being acceptable, the Contractor shall flush out, re-chlorinate and re-test as previously specified at no additional cost to the contract.

10) Practical completion of the works shall not be given until chlorination is complete and full satisfactory laboratory results have been obtained.

The Contractor shall employ one of the previously listed 'Water Treatment Specialists' to carry out the domestic water services sterilisation.

2A-8 RECORDS AND DOCUMENTATION

On completion of the activities described within this section of the specification complete records of ALL completed works and certificates of compliance shall be provided to both the design team and within the Operating and Maintenance Manuals.

Incomplete, non-compliant or unsatisfactory, in terms of compliance with the Standards listed in this specification, shall require all pre-commissioning, cleaning, flushing and sterilisation to be carried again at no cost to the client.

As an aid to meet this requirement for complete records and documentation all of the following must be provided at the relevant contract programme stages and a complete set of these documents shall be included within the Operating and Maintenance Manuals:

1) Record of all Local Water Authority and WaterSafe Registration to verify the potable water installation is fully WRAS compliant.

2) Pressure test certificates for every service.

3) Non-destructive test certificates for welded and brazed pipework.

4) Flushing certificates.

5) Water sample test result certificates.

6) Full UKAS certification of EVERY water system to verify the installation are fully compliant with regulations, best practice guideline and industry standards.

7) Certificate of manufacturer's satisfaction of the installations where plastic, press fit or grooved pipework systems have been installed.

8) Records of actual biocides and inhibitors used, and concentrations recorded for each system so that the client has a record of how the systems need to be treated, etc.

9) Example record sheets provided in BSRIA BG29 pre-commissioning and cleaning document shall be used as a basis for pre-commissioning and cleaning record keeping.

10) An acceptable water quality certificate of conformity for system cleanliness shall be provided for each water system. A typical example of an acceptable acceptance certificate is provided within BSRIA BG29.

11) Any other relevant documents that will be beneficial to the client over the life of the building.

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Section Two (B)

General Installation Clauses - Ductwork

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2B-1 INTRODUCTION AND INTERPRETATION

The Contractor shall supply, install and commission the ductwork installations as detailed on the tender drawings and within this specification, employing specialist ductwork manufacturers / installers as necessary.

2B-1-1 DEFINITIONS

Please refer to definitions contained in BESA DW documents and:

DEFINITIONS / ABBREVIATIONS	
Duct Diameter	Diameter of duct section or equivalent diameter of rectangular or flat oval duct.
Specialist	Specialist ductwork manufacturer or fitters employed by the Contractor.
FBPP	Fabric backed polypropylene sheet
FOAM	Rigid polyurethane self-extinguishing foam
GRP	Glass reinforced plastic
PP	Polypropylene
PPS	Self-extinguishing polypropylene
UPVC	Unplasticised polyvinyl chloride

2B-1-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the ductwork installations.

2B-2 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BESA DW 143 Guide to Good Practice - Ductwork air leakage testing	BS EN 13403 Ventilation for Buildings. Non-metallic ducts. Ductwork made from insulation duct boards
BESA DW 144 Specification for sheet metal ductwork	BS EN 15423 Ventilation for buildings. Fire precaution for air distribution systems in buildings
BESA DW145 Guide to Good Practice for the Installation of fire and smoke dampers	BS EN 13501 Fire classification of construction products and building elements
BESA DW154 Specification for plastics ductwork	BS EN 15650 Ventilation for buildings. Fire dampers
BESA DW172 Specification for kitchen ventilation systems	BS EN 15727 Ventilation for buildings. Ducts and ductwork components, leakage classification and testing
BESA TR 19 Internal cleanliness of ventilation systems	BS EN 15780 Ventilation for buildings. Cleanliness of ventilation systems
BESA TR 35 Low Energy Ventilation for Residential Buildings	BS EN 16798 Energy performance of buildings. Ventilation for buildings
BS 9999 Code of practice for fire safety in the design, management and use of buildings	BS EN 15882-2 Extended application of results from fire resistance tests for service installations. Fire dampers
BS EN 1366 Fire resistance tests for service installations	BS ISO 10294 Fire resistance tests. Fire dampers for air distribution
BS EN 1506 Ventilation for Buildings. Sheet metal air ducts and fittings with circular cross-section	BS ISO 21927-8 Smoke and heat control systems. Smoke control dampers
BS EN 1507 Ventilation for Buildings. Sheet metal air ducts and fittings with rectangular section	CIBSE Guide B2: Ventilation and Ductwork
BS EN 12097 Requirements for ductwork components to facilitate maintenance of ductwork systems	CIBSE TM26 Hygienic maintenance of office ventilation ductwork
BS EN 12101-8 Fire and heat control systems. Smoke control dampers	CIBSE TM30 Improved Life Cycle Performance of Mechanical Ventilation Systems
BS EN 12236 Ventilation for Buildings. Ductwork hangers and supports	LPS 1162 LPCB approval and listing of fire dampers
BS EN 12237 Ventilation for Buildings. Ductwork. Strength and leakage of circular metal ducts	

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Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2B-3 DUCTWORK CLASSIFICATION AND AIR LEAKAGE LIMITS

Ductwork shall be manufactured, installed and tested to the required pressure ratings defined below.

This section details the minimum requirements for all projects, the Contractor shall refer to the particular sections of this specification for any more onerous requirements for this particular installation.

TOTAL SYSTEM FAN PRESSURE (PA)	PRESSURE TEST CLASSIFICATION	MAXIMUM AIR VELOCITY (M/S)
-500 to +500	Low pressure Class A	10
-650 to -500 and +500 to +1000	Medium pressure Class B	20
-750 to -650 and +1000 to +2000	High pressure Class C	40
0 to -750 and 0 to +2000	High pressure Class D (where detailed within the specific specification)	40

- Where specific system pressure classifications are not detailed later in this specification, the external static pressure plus 10% allowance of the fan or air handling unit shall determine the required classification of the ductwork system from the schedule above.
- Where the air handling units are required to be pressure tested for air leakage the total fan pressure of the higher pressure sections of the supply or extract fans shall determine the pressure test classification. It is expected that AHUs are often tested at a higher classification than the connected ventilation ductwork.
- DW154 only covers construction up to 1,500 Pascals.

The Contractor shall provide documented evidence of the calculations used to arrive at the allowable loss for any section to be tested and the Client or their agent, shall witness and sign the results of the test.

The ductwork pressure tests shall include all components, air handling units, attenuators, dampers, etc. The Contractor shall ensure that all components, etc. are fully compatible with the required leakage classification.

PRESSURE TESTING SHALL ONLY BE CARRIED OUT ONCE ALL ACCESS DOORS REQUIRED FOR COMPONENT ACCESS AND REQUIRED FOR INITIAL & ONGOING CLEANING HAVE BEEN INSTALLED.

The ductwork cleaning Specialist shall attend site during the ductwork installation and advise the ductwork installer of all necessary additional access panels or hatches required for cleaning both initially and during the life of the ductwork installation. The ductwork installer shall install all these recommended additional access panels as part of the initial ductwork installation as quality of installation and overall airtightness is the responsibility of the ductwork installer. This is a departure from TR/19 where it is suggested that the cleaning Specialist installs any additional access panels as required.

In summary, under table 3 of BESA TR/19, including supporting notes, the ductwork installer shall be responsible for the installation of ALL access doors required whether listed as being installed by both the Ductwork and Cleaning Specialist. That is, all access doors shall be installed by the Ductwork Contractor as required by TR/19, DW144 and as recommended as being required by the Cleaning Specialist. All access doors shall be installed prior to any pressure testing taking place. No additional access doors shall be installed for cleaning purposes after the ductwork has been pressure tested.

A reputable duct cleaning company, company selected to be agreed with the Engineer, shall be employed by the Mechanical Contractor (not the Ductwork Contractor) to review and confirm in writing that there are sufficient access doors installed for cleaning purposes. If additional access doors are advised necessary then the ductwork shall be re-pressure tested for leakage at the Mechanical Contractors expense at a time that does not impact on the Contract Programme.

All access panels and hatches shall be installed to avoid being obstructed by the installation of additional services, such as pipework and cable trays. This is most practically achieved by initially showing all necessary access doors and hatches on the fully coordinated Building Information Modelling (BIM) model and during construction the ductwork contractor shall position access points while reviewing the coordinated services installation drawings and actual installation simultaneously.

The Contractor shall include for all costs associated with testing the systems as detailed below. Any additional works and testing required due to a failed test shall be completed at the Contractor's own expense along with any associated re-insulation, etc. required to complete the works.

2B-3-1 EXTENT OF PRESSURE TESTING

THE FOLLOWING TABLE SUPERSEDES THE GENERAL REQUIREMENT OF APPENDICES AS DETAILED IN BOTH BESA DW144 AND DW154 REGARDING MANDATORY PRESSURE TESTING OF VENTILATION SYSTEMS.

FOR THIS PROJECT, PRESSURE TESTING SHALL BE AS SCHEDULED BELOW, UNLESS ADVISED OTHERWISE WITHIN THE PARTICULAR SECTIONS OF THIS SPECIFICATION.

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PROJECT TYPE	PRESSURE CLASSIFICATION			
	A	B	C	D
Healthcare	100%	100%	100%	100%
Pharmaceutical	100%	100%	100%	100%
Laboratory (excluding secondary school laboratories)	100%	100%	100%	100%
Low energy buildings	100%	100%	100%	100%
Public buildings	20%	100%	100%	100%
Kitchens	100%	100%	100%	100%
Education (includes secondary school laboratories)	10%	50%	100%	100%
Retail	10%	30%	100%	100%
Offices	10%	30%	100%	100%
General extract only systems where no heat recovery used	0%	30%	100%	100%
Small systems (<1000 l/s) in Education/ Retail/ Offices	0%	30%	100%	100%

Where detailed as 0%, pressure testing is not required unless:-

1) Visual inspection shows deviation from the applicable installation standards.
2) Air leakage is apparent which, in the Engineer's opinion, is excessive.
3) Visual inspection reveals poor workmanship or where poor installation techniques have been used.

In the case of any of the above occurring, the ductwork systems shall be pressure tested and rectified as described below at the Contractor's own expense.

For partial pressure testing, the following shall apply:-

1) The Engineer shall select at random the required percentage for each of the duct systems to be air leakage tested.
2) The duct shall be tested at the pressure recommended for the classification, the tests shall be periodically performed as the works proceed.
3) In the event of any test failure of the randomly selected section, the Contractor shall inspect and rectify the section and retest, this shall continue until the required leakage rates are achieved. The remainder of the system shall be inspected and any faults rectified. The Engineer shall then select two further sections of similar length to the original section at random for testing.
4) If failures are identified within these further sections, the Engineer shall require additional testing of the remainder of the system, and any necessary corrective works in order to satisfy the maximum leakage rates for the pressure classification of the system.

High pressure class C and D systems shall be pressure tested in their entirety with any necessary remedial works and re-testing required to demonstrate that the complete system satisfies the maximum leakage rates for the pressure classification.

2B-3-2 POSITIVE AND / OR NEGATIVE PRESSURE TESTING

Unless stated otherwise, in this specification, all the ductwork systems shall be tested as follows:

SYSTEM	PRESSURE TESTING	NOTES
Supply air only AHU	Positive	
Extract air only AHU	Negative	Incudes bathroom / toilet extract systems.
Combined supply and extract AHU	Positive and Negative	Supply only if agreed with Engineer
Fresh air intake ductwork into AHU	Negative	Ductwork fully tested but intake plenums shall only be visually inspected.
Exhaust air ductwork from discharged from AHU	Positive	
Supply air ductwork	Positive	
Extract air ductwork	Negative	

2B-4 PDI LEVELS OF CARE, PROTECTION AND CLEANLINESS

2B-4-1 CLEANLINESS CLASSIFICATION

Unless stated otherwise, in this specification, all the ductwork systems shall be provided to the following cleanliness standards as defined in BS EN 15780 and BESA TR/19. Unless stated elsewhere in this specification, all new ductwork installations shall be required to be installed and tested for the Cleanliness Quality Classes listed below:-

BESA CLEANLINESS QUALITY CLASSES		
SYSTEM DESCRIPTION	CLASS	ADDITIONAL REQUIREMENTS
Local extract systems < 500 l/s	Low	Small toilet extract systems

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BESA CLEANLINESS QUALITY CLASSES		
SYSTEM DESCRIPTION	CLASS	ADDITIONAL REQUIREMENTS
General and dirty extract systems	Medium	
Kitchen extract	Medium	
General extract/ return air systems	Medium	
General supply air systems	Medium	
Healthcare premises serving sensitive areas e.g. theatres, wards, isolation rooms, treatment rooms	High	See cleaning requirements detailed within this specification
Laboratories	High	
Pharmaceutical	High	
Supply/ return air serving clean rooms and containment suites	High	See cleaning requirements detailed within this specification. Capping off during transport and storage
Any system not detailed above	Medium	

For ANY specified cleanliness quality class, the Contractor shall include for and be responsible for ensuring that the dust contamination levels do not exceed acceptable dust accumulation levels in new ductwork as scheduled in BESA TR/19.

Where sensors and test points are required to be drilled post installation, the resulting swarf shall always be cleaned from the internal finish using the nearest access hatch.

The Contractor shall employ a Specialist to test all the ventilation systems:-

- Test to be completed immediately prior to completion.
- Each system to be tested in a position agreed with the Engineer.
- Larger systems (greater than 50m of duct) shall be tested at 50m intervals.

Where the system contamination level exceeds the permissible level, the entire system shall be cleaned by a Specialist Contractor and then re-tested until acceptable levels are achieved, all at the Contractor's own expense.

It is highly recommended that the ductwork is kept internally clean in accordance with the recommendations of the appropriate 'Protection, Delivery and Installation (PDI)' standard for the complete installation of each system to minimise the post installation cleaning necessary. A clean installation may only require a cleanliness test on completion to meet the cleanliness requirements defined in BESA TR/19.

2B-4-2 SYSTEM PURGE

Prior to final commissioning and before carpets and furniture are installed within the building, the ductwork shall be thoroughly blown through and cleaned out. This operation shall be carried out with the maximum volume of air obtainable from the system, within the capacity of the particular fan, and particular care shall be taken to prevent over-loading of fan motors at this time caused by or due to possible low system resistance.

Purging shall:

1) Be completed before final connections are made.
2) If building works are still in progress or dirt is still present, temporary filters shall be used for the purge cycle, as an alternative, the system filters may be used then replaced with new filters at practical completion.
3) Extract and return systems shall not be purged until building work is complete and all areas served are clean.

Ductwork shall be blown through prior to the final fitting of the specified plant filters.

2B-4-3 DUCTWORK CLEANING (HEALTHCARE, LABORATORY AND PHARMACEUTICAL PROJECTS)

All healthcare, laboratory, pharmaceutical and systems to high cleanliness quality shall be cleaned after installation.

Ductwork to be cleaned in accordance with BESA TR/19 to the following requirements:-

1) No labels shall be applied to internal surfaces.
2) On completion of installation, ductwork shall be cleaned throughout by air lance to remove all dust and debris.
3) Prior to handover, the completed ductwork installation shall be cleaned by process of disinfection.
4) This work to be undertaken by Specialist Cleaning Contractors.

At a number of points throughout the system (at least one point per system and every 20m of duct on large systems), the mechanical cleaning shall be verified. Verification shall be by means of a vacuum test (V.T.), as described in TR/19. The results of the vacuum test must be fully compliant with TR/19.

Upon completion of the disinfection process, samples shall be taken and analysed by the Infection Control Officer, any section of duct that fails these tests shall be re-cleaned and re-tested until satisfactory results are obtained. All cleaning and testing costs due to failure of a section of ductwork shall be at the Contractor's own expense.

On completion, a comprehensive report shall be provided. This shall clearly state the following information:-

1) The ventilation system(s) cleaned.
2) Cleaning methods used.
3) Verification results.
4) Photographic evidence with location plan(s).

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5) Additional works carried out (if any).

6) COSHH data on any chemicals used for cleaning or biocidal treatment.

7) Recommendations for future testing and cleaning requirements.

All works to be completed to the satisfaction of the Infection Control Officer, independent verifier and Engineer.

2B-4-4 ASSESSMENT OF SYSTEM STATIC PRESSURE

In order to meet maximum operating efficiencies of the plant, all fans and belt driven items of equipment shall be re-pulleyed at final commissioning stages. All costs associated with the re-pulleying of each fan shall be included, no extra monies shall be forthcoming for failure to comply with this request.

The re-pulleying shall be undertaken to provide the design system air flow rates and shall be undertaken after proportional commissioning and in lieu of the final volume control adjustments for the whole of the ductwork system.

Where the fan motor is direct drive, the motor frequency must not be increased by more than 10% of the manufacturer selected speed or less as determined by the available electrical power supply, associated wiring and controls or design noise level limits. Under performance of the plant airflow below the design value shall be rectified by the plant manufacturer at no cost to the Client.

2B-4-5 COMPONENT PRESSURE DROP REVIEW

Upon completion of the working drawings and prior to commencing the manufacture/ installation, the Contractor shall review the pressure drop of the system components. The component selection shall achieve the following:-

1) All branches serving terminal devices shall have a similar resistance at design air flow (all devices shall fall within the range of +/-10% of the average of all outlets).

2) All duct components (coils, attenuators, etc.) shall have a similar pressure drop, i.e. fall within the range of +/-10% of the average of all similar components in each system.

3) Review with the Commissioning Engineer that main and sub-main branches are capable of being balanced without exceeding the following pressure drops through the volume control dampers:-

   a) Branch off main leg (not directly serving any terminal device) 40Pa

   b) Sub-branch serving a number of terminal devices (nearest terminal shall be at least 3 duct diameters from the volume control damper) 30Pa.

   c) Final leg dampers serving a terminal device 15Pa.

Where excessive noise regeneration is caused within the occupied zones due to the above not being complied with, the Contractor shall complete ductwork modifications and/ or provide secondary attenuators and any necessary re-testing at their own expense.

2B-5 DUCTWORK GENERALLY

All galvanised steel ductwork shall be installed to the DW144 standards with the following additional requirements:-

1) Steel ductwork shall be manufactured from best quality cold reduced continuously hot dipped galvanised sheet steel, with a minimum sheet thickness of 0.8mm.

2) Where specified, stainless steel ductwork shall be in accordance with DW 144 in particular Appendix D.

3) Fixing by self-tapping screws is not acceptable at all due to the risk of injury to operatives during the life of the ventilation system for cleaning, inspection and damper testing.

4) Fixings shall be mechanically closed to negate leakage.

5) During supply, delivery & installation all open ends shall be temporarily sealed to prevent ingress of dirt, dust, water, etc.

6) Self-adhesive tape shall not be used to seal ductwork.

7) Internal duct stiffeners or flanges shall not be used.

8) All ductwork and fittings shall be new, the use of secondhand materials shall not be accepted.

9) All site cut apertures shall be filed smooth and flush to minimise turbulence and provide a safe edge.

STANDARD COMPONENTS - RECTANGULAR				
THE FOLLOWING SCHEDULES STANDARD DW144 & DW 191 COMPONENTS AND ADVISES WHETHER THEY ARE PERMITTED OR NOT ON THIS PROJECT				
DW 144 FIGURE NO.	DW 191 FIGURE NO.	DESCRIPTION	PERMITTED? YES? / (NO)	NOTES
39	-	Mitred Throat Bend	No	
40	39	Short Radius Bend	No	
41	40	Medium / Long Radius Bend	Yes	
42	-	DW 144 'Hard' and 'easy' bends	Yes	Hard bends shall have a minimum radius of duct short side divided by two (÷2). Easy bends shall have a minimum radius of duct long side divided by two (÷2).
43	41	Short Radius Bend with splitters	Yes	Not permitted without splitters.
44	42	Square Bend with turning vanes	Yes	

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STANDARD COMPONENTS - RECTANGULAR				
THE FOLLOWING SCHEDULES STANDARD DW144 & DW 154 COMPONENTS AND ADVISES WHETHER THEY ARE PERMITTED OR NOT ON THIS PROJECT.				
DW 144 FIGURE NO.	DW 154 FIGURE NO.	DESCRIPTION	PERMITTED? YES / NO	NOTES
		and Mitred elbow		
45	43	Radius Tee with radiused back plates / internal deflectors	No	Not permitted with or without splitters / deflectors.
46	44	Radiused Twin Bend	Yes	
47	-	Swan Neck Bend	Yes	Only permitted for exhausts at roof or similar locations.
48	45	Swept Branch	Yes	
49	46	Square Tee with turning vanes	No	
50	47	Breeches Piece	No	Only permitted if agreed with Engineer.
51	48	'Y' Piece	Yes	
52	49	Angled Offset	Yes	
53	50	Mitred Offset	Yes	
54	51	Radiused Offset	Yes	
55	52	Concentric Taper	Yes	Limited to 22.5° in either plane.
56	53	Eccentric Taper	Yes	Limited to 22.5° in either plane.
57	54	Offset Taper	Yes	Limited to 22.5° in either plane.
58	55	Rectangular to Round Transformation	Yes	
59	56	Rectangular to Flat Oval Transformation	Yes	
60	57	Square Branch	No	
61	58	Angled Branch	Yes	Maximum of 45° angle permitted.
62	59	Shoe Branch	Yes	
63	60	Bell Mouth Branch	Yes	
64	61	Bell Mouth	Yes	Velocity of bell mouth to meet design noise level.
65	62	Telescopic Joint	No	Not required on modern projects.
66	63	Single Blade Damper	No	For DW154 only if agreed with engineer.
67	64	Non-Return Damper	Yes	
68	65	Multi-Leaf Damper	Yes	
69	66	Blast Gate Damper	No	For DW154 only if agreed with engineer.
70	67	Fire / Smoke Damper	Yes	Not permitted on DW 172 compliant systems. For DW154 only if agreed with engineer and Fire Advisor
71	68	Access Openings	Yes	
72	69	Flexible Connection	Yes	Not permitted on DW 172 compliant systems. For DW 154 limited to 250mm maximum.
73	70	Dropped cheeked reducing radiused twin bend	No	
74		Dropped cheeked reducing bend radiused or mitred throat	No	
	71	Drop cheek bend	No	
75	72	Airflow Symbol	Yes	

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STANDARD COMPONENTS - RECTANGULAR				
THE FOLLOWING SCHEDULES STANDARD DW144 & DW 154 COMPONENTS AND ADVISES WHETHER THEY ARE PERMITTED OR NOT ON THIS PROJECT.				
DW 144 FIGURE NO.	DW 154 FIGURE NO.	DESCRIPTION	PERMITTED? YES(Y)/NO)	NOTES
-	73 to 77 Inclusive	Air Terminal Plenums	Project specific	For DW154 only as agreed with engineer.
ADDITIONAL COMMENTS				
For DW 144, turning vanes shall be of the double skin aerodynamic type.				
Turning vanes shall not be used in kitchen extract systems.				
Duct branch reduction in duct size shall be by a separate taper piece fitting located 1 duct diameter downstream of the branch.				
Site fitted branches shall not cause resistance or turbulence over and above an equivalent factory manufactured branch. The aperture shall be cut using a template such that the full diameter of the boot connection is maintained subject to:- 1) Being smooth with no internal protrusion (Low/ medium pressure class A/B) 2) Having a maximum 5mm protrusion to the perimeter. A secondary internal seal shall be applied on high pressure Class C/D systems. 3) All edges shall be flat/ true and filed smooth to minimise air turbulence and prevent injury to maintenance operatives. 4) Branches shall be staggered to reduce air turbulence.				

STANDARD COMPONENTS - CIRCULAR				
THE FOLLOWING SCHEDULES STANDARD DW144 COMPONENTS AND ADVISES WHETHER THEY ARE PERMITTED OR NOT ON THIS PROJECT.				
DW 144 FIGURE NO.	DW 154 FIGURE NO.	DESCRIPTION	PERMITTED? (YES) / NO)	NOTES
91	78	Straight Duct with male and female connectors	Yes	
92	79	Straight Duct with flanged joint and slip joint	No	Flanged joints permitted if detailed in design proposals.
93	80	Pressed Bend Bend Moulded / Formed	Yes	Minimum throat of 1 duct diameter.
94	81	Segmented Bend	Yes	Minimum throat of 1 duct diameter.
95	82	Segmented Twin Bend	Yes	Minimum throat of 1 duct diameter.
96	83	Pressed Equal Tee Equal Tee Moulded / Formed	Yes	
97	84	Pressed Twin Bend Twin Bend Moulded / Formed	Yes	Minimum throat of 1 duct diameter.
98	-	(Concentric & Eccentric) Taper	Yes	Limited to 22.5° in either plane.
-	85	(Concentric & Eccentric) Taper	Yes	Concentric limited to 15°. Eccentric limited to 30°.
-	86	Short Taper	No	
99	-	Pressed Taper	Yes	Limited to 22.5° in either plane.
100	87	Offset	Yes	For DW 154, up to 30° max.
101	-	Square Branch	No	
102	88	Shoe Branch	Yes	Circular branch off a rectangular duct.
103	89	Conical Branch	Yes	
104	90	Angle Branch	Yes	Maximum of 45° angle permitted.
105	-	Square Branch	No	
106	-	Shoe Branch	Yes	
107	-	Pressed Branch	No	
108	92	Bell Mouth Branch	Yes	
109	93	Mitred Branch	Yes	
110	95	Blank End	No	Only permitted when duct will be

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STANDARD COMPONENTS – GRP/GEAR				
THE FOLLOWING SCHEDULES STANDARD DW144 COMPONENTS AND ADVISES WHETHER THEY ARE PERMITTED OR NOT ON THIS PROJECT.				
DW 144 FIGURE NO.	DW 154 FIGURE NO.	DESCRIPTION	PERMITTED? (YES / NO)	NOTES
				extended in future.
111	96	Multi-Leaf Damper	Yes	Flanged or spigotted, opposed blade only unless proportional control damper which shall be parallel blade.
112	97	Single Bladed Damper	No	Refer to particulars section, if permitted up to 315mm diameter.
113	98	Non-Return Damper	No	
114	99	Iris Damper	No	
115	-	Blast Gate Damper	No	Refer to particulars section.
116	100	Fire / Smoke Damper	Yes	Label as FD – Fire Damper / SD – Smoke Damper For DW154 only if agreed with engineer.
117	94	Breeches Piece	No	
118	101	Access Openings	Yes	
119	102 to 105 inclusive	Discharge Cowls	Yes	Refer to particulars section.
ADDITIONAL COMMENTS				
Duct branch reduction in duct size shall be by a separate taper piece fitting located 1 duct diameter downstream of the branch.				
Site fitted branches shall not cause resistance or turbulence over and above an equivalent factory manufactured branch. The aperture shall be cut using a template such that the full diameter of the boot connection is maintained subject to:- 1) Being smooth with no internal protrusion (Low/ medium pressure class A/B) 2) Having a maximum 5mm protrusion to the perimeter. A secondary internal seal shall be applied on high pressure Class C/D systems. 3) All edges shall be flat/ true and filed smooth to minimise air turbulence and prevent injury to maintenance operatives. 4) Branches shall be staggered to reduce air turbulence.				

2B-5-1 CONNECTION TO PLANT AND COMPONENTS

All connections onto plant and components must always be strictly in accordance with the manufacturer's best practice recommendations and must avoid wasting fan energy unnecessarily.

2B-5-2 FLEXIBLE CONNECTIONS FOR VIBRATION ISOLATION OF PLANT

All fans and items of plant containing moving equipment shall be provided with flexible connections to prevent transmission of vibration. All flexible connections shall:-

1) Be manufactured from suitable sound absorbing material.
2) Have 100mm to 250mm duct/ component separation.
3) Be securely bonded to the plant/ duct:-
   a) Sandwiched between flanges where provided on fan/ plant (duct connection shall also be flanged).
   b) Fixed using two worm drive clips when fan/ plant has spigot connections.
4) Withstand the working pressure of the system and comply with the leakage rates specified.
5) Not take out misalignment. Plant / duct shall be accurately aligned (max. 5mm tolerance).
6) Provide a resistance to penetration of fire of at least 30 minutes. In addition, they shall provide a Class 1 resistance to surface spread of flame.
7) Have resilient anti-vibration pad provided under any supports, except where spring anti-vibration mounts are required as detailed elsewhere in this specification.

2B-5-3 FLEXIBLE CONNECTIONS FOR CONNECTION TO GRILLES / DIFFUSERS

The ducting shall be as manufactured by Lindab their thermally insulated **Tecsonic 'S' 500** range of ducting with transparent liner between inner core and fibreglass layer.

Where indicated on design drawings or specifically allowed within the particular sections of this specification, final connection to grilles/ diffusers shall be completed using flexible connections shall:-

1) Under no circumstances shall flexible ductwork be used to form 90° elbows unless agreed with the engineer in writing and this agreement / allowance shall not be made at tender as elbows using flexible ductwork shall only be permitted under exceptional circumstances only.
2) Flexible ductwork shall be of the self-supporting, semi rigid type with each length being approximately between 400 and 600mm long.

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3) Have a maximum misalignment of 100mm.

4) Have a core of flame retardant, multiple layer, aluminium/ polyester laminate, permanently bonded to a fully encapsulated high tensile steel spring coil.

5) Be factory pre-insulated ducts with 25mm high density mineral wool insulation, sheathed with a tough scuff resistant reinforced aluminium/ polyester laminate outer deck where connected to insulated ductwork.

6) The flexible duct shall extend over the duct/ spigot by at least three helixes and be sealed with adhesive to provide an airtight seal. Two worm drive clips shall then be applied to give mechanical strength to the connection.

7) Flexible ducts shall not pass through fire rated walls, floors, partitions or any element of the building fabric that provides acoustic separation.

8) In areas of high fire risk (i.e. flammable liquid stores) flexible connections shall not be used.

9) Under no circumstances shall flexible ductwork be installed or compressed such that the total cross sectional area of the ductwork is reduced from its true straight cross sectional area.

The Contractor shall coordinate the grille / ductwork installation with all other trades, the building structure and ceiling grid to ensure that the maximum dimensions and tolerances detailed above are not exceeded. Any modifications necessary to fully comply with this specification shall be completed at the Contractor's own expense.

2B-5-4 PLENUM BOXES

Each grille/ diffuser shall be supplied with a plenum box connection as detailed below or in accordance with the recommendations of the grille/ diffuser manufacturer to achieve optimum performance, whichever are the most onerous requirements shall be adopted: -

1) Plenum boxes shall be manufactured from galvanised steel.

2) Spigot connection shall be side entry type of the same diameter as the duct branch or in accordance with manufacturers recommendation whichever are the most onerous requirements.

3) Plenum boxes shall be manufactured to suit the available ceiling voids, configuration of terminal ductwork and grille or diffuser manufacturer's requirements for optimum performance.

4) Plenum box shall have a total minimum height of the duct spigot connection plus 75mm with the top of the spigot set at 25mm from the top of the plenum box and to manufacturer's requirements whichever is the most onerous.

5) Top entry plenum boxes shall only be used with the express written permission of the Engineer and shall, as a minimum:

   a) Be designed by the grille manufacturer to ensure that pressure loss, flow characteristics and noise regeneration of the grille/ diffuser is not affected.

   b) The plenum box shall be of the same size as the grille neck connection which shall extend 200mm before transforming (refer to changes of ductwork section) to the required duct branch size.

Active sections of louvres shall be provided with plenum connections which shall:-

1) Be manufactured from galvanised steel sheet.

2) Provide even distribution of air across the active louvre face.

3) Have transformation pieces to and from the active plenum/ louvres.

4) Have a minimum depth of 450mm clear.

5) Incorporate a sloping floor and drain to discharge any water outside the building and prevent any ponding.

6) Be insulated/ vapour sealed and clad to the same standard as the connecting ductwork for fresh air plenums.

7) Be insulated/ vapour sealed and clad to the same standard as the fresh air duct for a distance of 2.5 m from the face of the louvre for exhaust air plenums.

Any remaining sections of louvre not used for air transfer or ventilation of the room shall be blanked off by the Contractor and insulated/ vapour sealed and clad to the same standard as the fresh air inlet ductwork. This shall be reinforced as necessary to ensure that the materials used to blank off the louvres are not dislodged or compromised by wind pressure.

Any other connections to external terminals such as roof cowls shall be completed using a short plenum with a minimum depth of 150mm before tapering to the required duct size.

2B-5-5 DUCTWORK PENETRATION OF STRUCTURE

Where ductwork passes through walls and floors other than fire barriers, a sleeve shall be provided, the sleeve shall:-

1) Be 2 gauges thicker than the associated duct, manufactured from galvanised steel.

2) Have a galvanised steel trim to prevent distortion.

3) Have space between sleeve and duct, packed with an approved sound isolation material suitable for the application and match the acoustic performance of the penetrated wall or floor.

Penetrations through roof shall be completely watertight and shall allow water to drain freely on the roof. A suitable fully welded cravat shall be provided with a skirt extending at least 150mm below the building flashing. If any welding is carried out the complete assembly shall be hot dip galvanised after manufacture.

2B-5-6 SUPPORTS AND FIXINGS

Supports shall be provided that are suitable for the weight and construction of the equipment and ductwork being supported. The method of support shall be agreed with the Engineer after assessing the suitability of the various alternative methods, which are compatible with the building structure (the Contractor shall obtain acceptance from the Structural Engineer for any fixing necessary to the building structure).

Suspended support systems shall:-

1) Have a minimum drop rod diameter of 10mm.

2) Be provided with two nuts, the second nut being to lock the fixing.

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3) Have 25mm by 2mm minimum flat bearing members.
4) Have 2500mm maximum spacing between supports.
5) Have filed smooth edges and where protruding into an access or walkway zone be capped or shrouded to prevent any risk of injury, in addition a clear method of hazard warning shall be applied.
6) Be isolated from the ductwork itself to prevent transmission of vibration (i.e. felt or foam strip).
7) Be thermally isolated from the duct to the same thermal performance as the adjacent insulation for insulated ductwork.
8) Continue the vapour seal without compromise of the seal in any way where adjacent to vapour sealed insulation.

On small ducts (up to 1.3m circumference or perimeter) wire type fixing may be used provided that they are suitable for the weight and construction of the ductwork, these shall be to the following minimum requirements:-

1) Specifically designed as a support system.
2) Wire shall be a galvanised stranded rope type with a minimum load bearing capacity of 90kg.
3) Stainless steel wire shall be used in wet environments and food preparation areas.
4) All wires shall be within 15° of vertical.
5) Weight shall be evenly distributed across all wires.
6) Hangers shall be fixed using stud ends which are locked in place with a double nut.
7) Where the Contractor obtains specific written approval of the Structural Engineer, loop end fixings may be used to fix to building steelwork, the method of fixing shall ensure that lateral movement cannot occur.
8) Hangers shall not distort the supported duct in any way.
9) Proprietary corner saddles shall be used on all rectangular ducts.
10) Lateral movement of the duct shall be fully arrested by means of intermediate conventional supports on straight runs or naturally due to bends/ branches within the system.
11) In line joints shall not be permitted.
12) Excess wire at fixings trimmed upon completion leaving a maximum tail of 50mm.
13) The insulation and vapour seal of the ductwork shall not be compromised.
14) The system shall be installed in accordance with the manufacturers recommendations, except where less onerous than described in this specification.
15) Shall not be used in a chlorinated atmosphere.

Other methods of support such as cantilever brackets, goal post brackets, etc. shall:-

1) Be suitable for the weight supported and fixing method to the building structure.
2) Be provided with two nuts, the second nut being to lock the fixing.
3) Have 2500mm maximum spacing between supports.
4) Have filed smooth edges and where protruding into an access or walkway zone be capped or shrouded to prevent any risk of injury, in addition a clear method of hazard warning shall be applied.
5) Be isolated from the ductwork itself to prevent transmission of vibration (i.e. felt or foam strip).
6) Be thermally isolated from the duct to the same thermal performance as the adjacent insulation for insulated ductwork.
7) Continue the vapour seal without compromise of the seal in any way where adjacent to vapour sealed insulation.

All plant and ductwork components shall be supported independently of the ductwork itself.

Diffusers/ grilles shall be supported independently of the ductwork/ ceiling grid unless stated otherwise within the specific relevant clauses of this specification.

2B-5-7 ANTI-VIBRATION MOUNTINGS

Specialist anti-vibration mountings shall be provided to all items of rotating or vibration producing plant, these mountings shall:-

1) Be selected by the manufacturer making allowance for building structure, weight and characteristics of the equipment supported.
2) Be of the laterally stable steel spring type.
3) May be neoprene mountings in the case of small axial fans (<500 l/s).
4) Limit vibration transmission to the structure, degree of isolation (vibration efficiency) shall be at least 95%.
5) Limit re-radiated air-borne noise to a maximum of NR 30 at 1 metre.

The mountings shall be manufactured by Messrs. TEK Ltd or equal and approved by the Engineer.

2B-5-8 EQUIPMENT SUPPORT AND PROTECTION

All plant items shall be provided with proprietary stands or supports that shall be:-

1) Provided whether shown the design drawings or not.
2) Independent of the adjacent distribution systems (ductwork or pipework, etc.)
3) Mounted on a weight bearing upstand which extends at least 50mm above finished floor level in order to maintain floor finish integrity where supported from the floor.
4) Manufactured from steel, painted before erection, except when installed externally or in a damp environment where the supports shall be hot dip galvanised after manufacture.

Details of supports shall be supplied to both the Engineer and Structural Engineer for comment prior to manufacture.

Any exposed moving machinery (i.e. drives, belts, fan blades, chains, projecting set screws, etc.) shall be provided with protective guards which shall:-

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1) Be manufactured from robust galvanised welded steel open mesh within a welded galvanised steel frame.
2) Be easily removed for maintenance access.
3) Not vibrate or transmit vibration to the building structure or equipment served.
4) Have removable bolted sections provided opposite the shaft ends to facilitate speed measurement.

2B-5-9 TEST POINTS

Test points shall be provided by the ductwork installer in all locations detailed within applicable standards to a minimum of before and after fans, filters, batteries, humidifiers, attenuators and volume control devices. All test points shall be plugged using rubber or plastic removable inserts on completion of all testing.

Insulation shall be dressed around test points such that insulation, vapour seals and cladding are not compromised and access can be obtained without damage to finishes/ function.

2B-5-10 PAINTING

All cut edges, supports, flanges, nuts and bolts and any other exposed metal shall be painted with two coats of red oxide paint before erection.

Where during the course of erection, the protective finish has been damaged or has not been effective; any items so affected shall be cleaned down and re-painted to match and suit the adjacent finish.

2B-6 DUCTWORK COMPONENTS

2B-6-1 VOLUME CONTROL DAMPERS

Volume control dampers shall be provided on every duct branch and final leg serving a diffuser or grille whether indicated on design drawings or not, final location and quantity of additional dampers for efficient, proportional balancing without regenerating noise shall be agreed with the Commissioning Specialist prior to tender submission.

Dampers shall be:-

1) Located as far upstream as possible from any diffuser, grille or bell mouth and not less than a minimum of 2 No. duct diameters.
2) Provided to each grille and diffuser, with a multi-blade opposed blade damper for 'fine tuning' (max. 10Pa) only. The damper shall not regenerate noise and shall be provided by the diffuser and grille manufacturer as one unit.

All duct volume control dampers shall:-

1) Be manufactured with multi-opposed aerodynamic double skin stainless steel blades suitable for balancing and shut off (maximum leakage 27 l/s at 1,000Pa when measured on a 1000mm x 1000mm damper).
2) Be positioned to minimise noise regeneration and turbulence so that the maximum additive (logarithmic) effect of 'in duct' noise level shall not exceed 3 dB, i.e. the noise level purely due to regeneration at the balancing damper shall not be greater than the 'in duct' noise level upstream of the balancing damper.
3) Be securely fixed and free from any vibration.
4) Have synthetic blade end bearings, stainless steel top and side spacing tempered flexible gasketing.
5) Be installed within a galvanised steel frame with blade drive mechanism outside the air stream.
6) Be operated by a lockable arm/ knob which shall be locked in place after commissioning.
7) Include a graduated plate which clearly indicates damper position and is clearly marked with final position after commissioning. It shall be possible to determine damper positions from external visual inspection without special access requirements.
8) Have extended shafts, motor mounting platforms and linkage where a damper is to be motorised (refer to drawings/ particular sections of this specification). Shaft length shall be sufficient to allow insulation and vapour seal shall be maintained beneath motor platforms, etc.
9) Not be Iris or single blade dampers.
10) Dampers shall be one of the following depending on the application:

PURPOSE	NOTE	DAMPER MANUFACTURER AND TYPE
Air balancing only	Permitted where some airflow leakage not detrimental.	Actionair Airshield Series Aerofoil
Air balancing and shut off requirement	Required where tight shut off and balancing required.	Actionair Airshield Series Aeroseal

2B-6-2 ACCESS DOORS

Access doors shall be installed fully in accordance with BESA DW documents, with the additional access doors required for future cleaning also installed during this installation, as required by the relevant standards applicable and shall:-

1) Not compromise the integrity of the ductwork system in terms of its pressure classification.
2) All access doors shall be the type and size recommended in BESA TR/19.
3) Be co-ordinated with all other services to prevent access being obstructed by pipework, cable trays, etc.
4) Be co-ordinated with building structure, ceiling supports and grids and with access doors in adjacent ceilings, walls, etc. provided by the builder.
5) Be operable from both within and outside the duct with clamping latches where provided to allow personnel to fully enter the duct.

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6) Be thermally insulated where the ducts are to be thermally insulated, the frame of the access door shall extend beyond the face of the duct by at least the insulation and protection thickness. The door shall be double skin construction completely encapsulating mineral insulation to provide the same thermal and vapour seal characteristics as the adjacent insulated duct.

7) Shall be either hinged or restrained with braided wire or chain so that the door is connected to the ductwork.

8) Shall not have any elements that protrude into the air stream or cause additional resistance.

9) Shall have flush and smooth internal finishes to prevent dust/ dirt collection or bacterial growth.

10) Shall be free from sharp edges.

Access doors shall be manufactured by Actionair Ltd or Engineer approved equal product.

LOCATION OF ACCESS PANELS AND HATCHES FOR INSPECTION, SERVICING AND / OR CLEANLINESS		
IN-LINE EQUIPMENT	LOCATION	NOTES
Volume Control Dampers	Both Sides	
Zone Isolation Dampers	Both Sides	
Fire Dampers	Both Sides	
Smoke Dampers	Both Sides	
Heating, Cooling and Heat Recovery Coils	Both Sides	
Reheat Coils	Both Sides	
Attenuators	Both Sides	
Filter Units	Both Sides	
Air Turning Vanes at Bends and Tees	Both Sides	
Changes in Direction	One Side	Both sides when change in direction has turning vanes.
In-Duct Fans / Other Devices	Both Sides	
Inlet / Exhaust Louvres	One Side	
Required for Cleaning Purposes	In accordance with TR/19 and DW/172.	

2B-6-3 ATTENUATORS

The specification and design drawings are based on initial attenuator selections only, the Contractor shall select the actual attenuators based on the performance criteria detailed within this specification and or the room data sheets when available.

The Contractor shall supply the following information to their Acoustic Specialist to allow for the correct attenuators to be selected:-

1) Sound power level for each fan or component selected.

2) Copy of working drawings.

3) Specified noise levels within all spaces supplied or passed through by the ductwork system (selection shall be based on break out and terminal noise levels).

4) Maximum air pressure drop through attenuators.

5) Drawings showing details of connections to inlet and outlet of attenuator.

In the absence of specific performance data being available, the following shall be assumed for tender purposes only. Final requirements shall be confirmed prior to ordering attenuators.

1) Required noise level in rooms shall be NR35 at 1m.

2) Required external noise level shall be NR45 at 3m.

3) Maximum pressure drop across the attenuators shall be 30Pa.

All Attenuators shall comply with the following:

1) The casing shall:-
   a) Be manufactured from pre-galvanised sheet steel.
   b) Shall have a minimum thickness of 1.2mm if either the width, height or diameter exceeds 1200mm.
   c) Shall have a minimum thickness of 1.0mm if both the width, height or diameter are less than 1200mm.
   d) Either Pittsburgh longitudinal joints or internal standing seam joints, all constructed to the relevant BESA DW Specification.

2) Splitters shall:-
   a) Be constructed from perforated or expanded galvanised steel sheet having a minimum thickness of 0.7mm
   b) Be contained within galvanised steel channels having a minimum thickness of 0.8mm, the splitter shall be riveted to the channel.
   c) Have aerodynamic fairings riveted or spot welded to the front of each splitter to minimise resistance.
   d) Have all fixings to the casing made using blind/ sealed rivets.
   e) Be half width at the side walls of the casing.

3) Infill shall:-
   a) Be inorganic mineral wool rigid slabs with a glass fibre tissue face to limit glass fibre erosion to negligible levels.
   b) Be inert, vermin, rot, moisture proof, non-combustible and not support bacteriological growth.
   c) Be packed to a minimum density of 45 kg/m^3.

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d) Be tested for fire and have a Class 1 spread of flame.

4) Connections shall:

a) Have 'mez' type 'slide on' flange connections to BESA DW Specification.

b) Have rolled angle steel silver leaded flanges fixed to casings with blind/sealed rivets on multi-section attenuators and shall have the casing returned at least 12mm over the end flanges.

c) Be provided with spigot ends for cross talk attenuators.

d) Have matching flanges, cleats, gaskets supplied and installed by the Contractor.

5) A label shall be provided indicating direction of air flow.

6) A label shall be provided detailing:-

a) Manufacturer

b) Type

c) Size

d) Location

e) Material used to encase mineral wool (glass fibre tissue or Melinex).

7) Attenuators handling air in clean conditions (i.e. hospitals, clean rooms, etc.) and fume extract shall have a Melinex lining completely encasing all of the mineral wool or glass fibre rigid slabs.

8) Attenuators handling air in kitchen ventilation/ extract and saturated atmosphere shall have a Melinex lining completely encasing all of the mineral wool or glass fibre rigid slabs, the perforated/ expanded steel lining shall be hot dip galvanised after manufacture.

2B-7 COMBINATION FIRE / SMOKE DAMPERS AND FIRE DAMPERS

2B-7-1 GENERAL

Fire dampers and combination fire and smoke dampers shall be installed to maintain the fire integrity and rating of the fire and smoke barrier that the ductwork is passing through. A damper shall be provided wherever ductwork penetrates a fire wall, ceiling, floor or compartment/ sub-compartment. Dampers shall be provided at these locations whether or not indicated on tender drawings.

The supply, installation and commissioning fire and combination fire & smoke dampers as necessary for compliance with the latest fire strategy drawings, fire engineering report, the approval of the Fire Advisor and Building Control shall be included.

Fire and smoke dampers shall be provided as required plus as below.

Combination fire and smoke dampers shall be provided in the following locations:

1) Within all plant room walls, floors and ceilings.

2) All riser walls, floor, ceiling slabs (to suit fire strategy).

3) All structural floors.

4) All walls enclosing escape routes.

5) Where ducts cross corridor walls where the corridor is part of the fire escape route.

Fire dampers shall be included based on the following criteria for tender purposes:

1) Within extended ceiling voids fire dampers shall be provided at 20 metre centres in all directions.

2) At intake and exhaust louvres where windows and fire escape routes are adjacent (within 3 metres for tender).

3) All remaining fire cavity barriers, Contractor to confirm fire cavity barrier locations with the Architect/ Main Contractor/Fire Advisor.

The Contractor shall confirm the location of all fire cavity barriers with the Architect / Main Contractor during the tender period, if no written clarification is given or received prior to tender, the Contractor shall allow for combined smoke & fire dampers and fire dampers as scheduled above.

THIS SHALL BE CHECKED PRIOR TO INSTALLATION AND VARIATIONS TO REDUCE REQUIREMENTS GIVEN AS NECESSARY.

All dampers must be installed fully in accordance with manufacturer's recommendations and the Fire Advisor's requirements.

2B-7-2 REQUIREMENTS FOR FIRE AND SMOKE DAMPERS

Requirements for ALL combined fire & smoke and fire dampers:-

1) Galvanised steel casing with continuously welded corners.

2) Spigot connections to suit ductwork system.

3) Manufacturer's installation frame shall protect the structural opening so the ductwork is not distorted during a fire condition. Contractor shall ensure correct frame is supplied for the type of structure penetrated.

4) External visual indication of damper open/ shut status.

5) Supported in accordance with the damper manufacturers recommendations to achieve the ratings described.

6) Each damper shall be provided with a local method of identifying its location, i.e. indicator mark on false ceiling below. Final detail to be agreed with Engineer/ Architect prior to implementation.

Combined Fire and Smoke dampers (mode 6) shall:-

1) Be manufactured by Actionair Limited, their Smoke Shield range.

2) Have stainless steel double skin aerofoil blades with double metal seal.

3) Have synthetic seal.

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4) Have snap lock interface to allow proportional torque control, suitable for accepting various drive actuators.

5) Be mode 6 operation, 240v motor opening, and spring closing on loss of power or operation of mechanical thermal link rated at 72°C.

6) Be no more than 200 $m^3/hr/m^2$ at 300 Pascals at ambient temperature.

7) Have volt free contact for remote indication of damper status.

8) Be provided with a unique reference (mechanically fixed traffolyte label) that mimics the referencing on the smoke control panel.

Fire dampers shall:-

1) Be manufactured by Actionair Limited, their Fire Shield range.

2) Have a stainless steel folding curtain with blades out of the air stream in the open position.

3) Have a mechanical release cassette with memory metal spring to close damper at 72°C.

4) Have stainless steel side gasket to minimise spread of smoke.

5) Have a mechanism suitable for single handed reset.

6) Be no more than 200 $m^3/hr/m^2$ at 300 Pascals at ambient temperature.

In addition to the damper itself, the following shall be provided for every damper:-

1) Supplied to site and installed with dampers in closed position.

2) Vacuumed out and opened immediately prior to commissioning.

3) Performance tested, witnessed by Commissioning Engineer and certified at commissioning stage.

4) Damper assembly and all linkages lubricated as recommended by the manufacturer.

The Contractor shall allow for full co-ordination of the installation frame with the Main Contractor during the construction work and ensure that the frame is installed in accordance with manufacturer's instructions.

2B-7-3 COMBINATION FIRE AND SMOKE DAMPER CONTROL SYSTEM

All of the smoke/ fire dampers shall be individually controlled and continuously monitored by a central panel supplied by the same manufacturer as the combination fire and smoke dampers.

The panel shall have:-

1) Lockable glazed door.

2) Number of latching switches to equal total number of installed dampers plus 15% spare capacity.

3) LED indicator for open/ closed status monitoring of each damper.

4) Lamp test facility.

5) Relays, timers, etc. to allow automatic control of system.

6) Audible alarm and mute facility.

7) Interfaces with fire alarm (one per compartment/ sub-compartment and plantroom/ riser space).

8) Interface to BMS using volt free contacts for status and alarm condition.

9) Interface to motor control centres for hard wired shut down of plant.

10) Fireman's key override switch interface (one per compartment/ sub-compartment and plant room space).

The Contractor shall include for all costs associated with the installation of the interconnecting wiring.

All power/ control wiring shall:-

1) Be halogen free low smoke and flame rated at 600/1000 volt.

2) Have 3 core cable from each damper to the control panel for status indication.

3) Have 2 core cable, power from control panel to each damper, with local spur complete with neon indicator.

4) Be mounted upon/ within suitable carcassing (i.e. cable tray).

5) Have power supply to spur adjacent to smoke panel by Electrical Contractor, final connections shall be by Contractor.

6) Have fire alarm interface adjacent to smoke control panel by Electrical Contractor, final connection by Contractor.

Upon completion of the mechanical installation works the dampers and control panel/ wiring shall be fully commissioned by the manufacturer.

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Section Two (C)

General Installation Clauses – Mechanical Commissioning

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2C-1 GENERAL REQUIREMENTS

This section of the specification identifies general testing and commissioning requirements applicable to all services and sections within this specification.

2C-2 DEFINITIONS

Commissioning – The advancement of an installation from the state of static completion to full working order to the specified requirements. It includes the setting to work of an installation, the regulation of the system and the fine tuning of the system.

Commissioning Specialist – The firm (or person) appointed by the Mechanical Contractor to carry out specified duties in connection with commissioning engineering services in accordance with the commissioning specification. The Commissioning Specialist shall be someone with relevant training and experience who is a corporate member of the Commissioning Specialists Association.

Commissioning Manager - The person belonging to or appointed by the Commissioning Specialist to manage the commissioning process, being responsible for overall planning, supervision and witnessing of the results of the integrated Commissioning of all installed building services. The Commissioning Manager shall be someone with relevant training and experience who is a corporate member of the Commissioning Specialists Association

Commissioning Management Organisation (CMO) - The firm (or person) appointed by the Main Contractor to manage the commissioning process, being responsible for overall planning, supervision and witnessing of the results of the integrated commissioning of all installed building services.

Engineer – The Mechanical and Electrical Engineering Design Consultant (CPW)

Controls Specialist – The firm appointed by the Mechanical Contractor to design, install, set to work and commission the automatic controls or Building Energy Management systems (BEMS/BMS)

For all other definitions refer to the relevant CIBSE Commissioning Codes.

2C-3 REFERENCE TO OTHER DESIGN DOCUMENTS

This section of the specification shall not be read in isolation. It must be read in conjunction with the other sections of this specification, the drawings and other documents referred to therein. The Mechanical Contractor is to ensure that their Commissioning Specialist has access to all of these and any other relevant documents during the tender and afterwards in the following construction phases.

2C-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS & GUIDES		
PUBLISHER	STANDARD	SUBJECT
BSRIA	AG16/2002	Variable flow water systems
BSRIA	AG20/95	Commissioning of pipework systems – Design considerations
BSRIA	BG2/2010	Commissioning water systems
BSRIA	BG8/2009	Model commissioning plan
BSRIA	BG11/2010	Commissioning job book - A framework for managing the commissioning process
BSRIA	BG25/2014	HVAC Troubleshooting
BSRIA	BG29/2012	Pre-commission cleaning of pipework systems
BSRIA	BG44/2013	Seasonal commissioning
BSRIA	BG46/2015	Domestic ventilation systems – A guidance for measuring airflow rates
BSRIA	BG49/2015	Commissioning air systems
BSRIA	BG63/2015	Building Performance Evaluation in Non-Domestic Buildings
BSRIA	BG64/2016	Building Performance Evaluation in Domestic Buildings
CIBSE	Commissioning Code A	Air distribution systems
CIBSE	Commissioning Code B	Boilers
CIBSE	Commissioning Code C	Automatic controls
CIBSE	Commissioning Code L	Lighting
CIBSE	Commissioning Code M	Management
CIBSE	Commissioning Code R	Refrigeration
CIBSE	Commissioning Code W	Water distribution systems
CIBSE	KS09	Commissioning variable flow pipework systems

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STANDARDS & GUIDES		
PUBLISHER	STANDARD	SUBJECT
CIBSE	TM31	Building Logbook toolkit
CSA	Guidance Note 2	Constant Flow Regulators
CSA	Guidance Note 3	Variable Volume Water Systems
CSA	Guidance Note 5	Site Safety for Commissioning Engineers
CSA	Guidance Note 8	Inverter Drives for Fans and Pumps
CSA	Guidance Note 10	Alternative Pipework Systems & Fixed Orifice Flow Measurement
CSA	Guidance Note 12	De-aeration in Hot Water Service Systems
CSA	TM 1	Standard Specification for the Commissioning of Mechanical Engineering Services Installations for Buildings
CSA	TM 2	Guide to Trouble Shooting for Air Distribution Systems
CSA	TM 3	Test Sheets
CSA	TM 4	Design of Collection Hoods for Testing & Balancing
CSA	TM 5	Efficient Control of System Water Quality
CSA	TM 7	Commissioning of Steam Systems
CSA	TM 8	Trouble Shooting Refrigeration Equipment
CSA	TM 9	Water Treatment and the Commissioning Engineer
CSA	TM 10	Site Performance Testing of Heating & Cooling Coils
CSA	TM 11	Alternative Pipework System & Fixed Orifice Flow Measurement
CSA	TM 14	Pressurisation Units, Design, Operation & Maintenance
CSA	TM 15	The Theory of Balancing Water Distribution Systems
CSA	TM 18	PICVs Function and Commissioning
CSA	TM 19	Thermal Balancing of HWS and CWS

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2C-3 SCOPE OF WORK

The Mechanical Contractor shall allow for a named, suitably qualified, Commissioning Specialist to undertake all commissioning work as detailed in this Specification and as follows:-

1) All management and advice activities during design, installation, pre-commissioning, commissioning and verification stages of the project. The management activities shall be compliant with the guidance given in the above 'Standards Applicable'. The commissioning activities shall be fully integrated into the construction process from the point of appointment of the Mechanical Contractor, right through to handover and beyond to fine tuning the building services during occupation. Appointing the Commissioning Specialist part way through the construction phase shall not be tolerated.

2) Early involvement in the project to advise on the commissionability of the building services design, whether that design is by the Engineer or the Mechanical Contractor and also advise on the time periods to carry this work so that it can be included in the overall construction programme. It is essential that this activity is undertaken in a timely manner to ensure that the systems can be commissioned satisfactorily without delay or additional cost.

3) Oversee all pre-commissioning activities carried out by the installers as prescribed in the aforementioned commissioning guides and as specified in this and other sections of the specification and drawings. This includes overseeing and verifying the commissioning activities of specialist plant items such as chillers, boilers, DX cooling systems, BMS, etc. which are often specialised in nature and are commissioned by the Manufacturer. The commissioning of specialist equipment, such as those aforementioned, especially where they integrate with the air and water distribution systems shall require careful consideration and integration within the commissioning plan. The Mechanical Contractor and the Commissioning Specialist shall agree any divisions of responsibility to fully appreciate their respective scopes of work.

4) All physical works involved in all commissioning activities including setting to work and dynamic proving in order to achieve the design intent. This includes returning to site for balancing and regulation adjustments during the maintenance period. Performance tests on heating and air conditioning systems shall be undertaken in peak weather conditions, irrespective of when completion takes place.

5) Demonstration to the Engineer a proportion of final system flow rates.

6) Provision of all seven formal stage gate reports.

7) Provision of all necessary documentation, including test records, commentary, diagrams and reports for O & M manuals.

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8) Give notice to the Building Control Body or Local Authority declaring that a commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard; and the results of the tests confirm that the performance is reasonably in accordance with actual building designs, including written commentaries where excursions are proposed to be accepted.

The Mechanical Contractor shall allow for all costs associated with the above and the foregoing being included within their tender price. It shall be noted that it is the Mechanical Contractor's responsibility to ensure that the Commissioning Specialist has viewed all tender documents and outline programme during tender stage to ensure that all necessary costs from their Commissioning Specialist have been included.

The Mechanical Contractor shall also include for all fees charged by the Nominated or other Insurance Companies for all supervision and examination at the manufacturers' works during construction of all pressure vessels and similar equipment and the witnessing of works tests in addition to site tests and the incidental work involved.

Two copies of all test certificates shall be supplied to the Commissioning Specialist.

2C-6 COMMISSIONING SPECIALIST

All commissioning works, except for equipment covered by 'Commissioning of Equipment by Manufacturers', listed at the end of this section, shall be commissioned by one of the following Commissioning Specialists, who are all 'Corporate Members' of commissioning Specialists Association (CSA). No other companies will be accepted for this work under any circumstances.

COMPANY NAME	TEL. NO.	EMAIL ADDRESS	LOCATED
Airtech Commissioning Limited	0121 4154141	heather.underhill@airtechcomm.co.uk	Birmingham
Airtech Premier Limited	01252 873723	enquiry@airtechpremier.co.uk	Hook
Ashfords	01784465 838	services@ashford-group.co.uk	Staines
Building Services Commissioning Limited	01522 868190	info@bscLimiteduk.com	Lincoln
Beech Technical Services Limited	0121 4591886	carlo.gambardella@beech-technical.co.uk	Birmingham
Cardiff Commissioning Limited	029 2052 1111	cardiffcomm@cix.co.uk	Cardiff
Central Commissioning (UK) Limited	01827 251379	enquiries@centralcommissioning.co.uk	Tamworth
CML Commissioning Management Limited.	01206 761911	mail@cml-group.co.uk	Colchester
Cross Count Limited	01279 508204	enquiries@crosscount.com	Stansted
End Systems Limited	01942 673229	enquiries@endsystems.co.uk	Leigh
GCS Commissioning	0117 9685074	office@gcscom.uk	Bristol
H & V Commissioning Services	01563 821991	talk2us@handv.co.uk	Ayrshire
Kebble Environmental Services Limited	01279 417 878	http://www.keslimited.co.uk	Harlow

2C-7 COMMISSIONING MANAGEMENT

Unless specified otherwise, the Commissioning Specialist shall manage their own activities, establish clear lines of communication and be responsible for ensuring the commissioning is completed in accordance with this specification and the agreed programme. For some large or complex projects, it may be necessary for the Main or Principal Contractor to employ a CMO. Should this be necessary, then the Commissioning Specialist would be informed of this intention within the specific section of the specification under the heading "COMMISSIONING MANAGEMENT" or similar. The Commissioning Specialists shall allow for all associated costs and time required where Commissioning Management is proposed for the project.

2C-8 HEALTH & SAFETY

The Commissioning Specialist has a duty under the Construction Design and Management Regulations to review the commissioning plan and bring any safety matters to the attention of the Main Contractor. Any actions resulting from this Health and Safety review shall be confirmed and managed by the Main Contractor prior to any commissioning work being undertaken. The Commissioning Specialist shall be aware of the general risks associated with building services and be conversant with applicable legislation.

Reference shall be made to Health & Safety Legislation affecting Commissioning and the Safety sections contained within the relevant commissioning codes.

2C-9 WITNESSING AND VERIFICATION

Witnessing and verification of tests shall be required to enable confidence to be established for the commissioning results. Unless specified otherwise, the witnessing and verification shall be undertaken by one of the following depending on the particular project:

1) Where an additional Commissioning Specialist is employed for the role of Commissioning Management, all witnessing and verification of the complete system shall be carried out by the Commissioning Specialist and fully witnessed in its entirety by the Commissioning Manager.

2) Where a Clerk of Works is employed, all witnessing and verification of the complete system shall be carried out by the Commissioning Specialist and fully witnessed in its entirety by the Clerk of Works. Some of the more simple installations may only require a percentage of the systems to be witnessed by the Clerk of Works. The percentage of the system to be partially witnessed shall be agreed with both the Clerk of Works and Engineer prior to the commissioned systems being offered for witnessing and verification. At tender allow for all systems to be 100% witnessed.

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3) Where neither of the above applies, the Commissioning Specialist shall also allow for a proportion of tests to be witnessed by the Engineer. The proportion of tests to be witnessed by the Engineer shall be 20%, though this could be reduced to 10% at the discretion of the Engineer on very large systems.

4) For all projects, the Engineer has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful. In this instance, the Mechanical Contractor shall bare all additional costs associated with this additional work.

5) For all projects, the Commissioning Specialist shall inform the Engineer of the verification programme who shall at their discretion, invite the Client representative.

6) For all projects, the Commissioning Specialist shall obtain counter signatures on all commissioning sheets to obtain certification that the results are within tolerance. No re-writing of test sheets shall be permitted following witnessing by the Commissioning Manager, Clerk of Works or Engineer.

7) For all projects, the commissioning specialist shall witness and verify 100% BMS and controls hardware and software function, integration and performance.

2C-10 TESTING AND PRE-COMMISSIONING

The Mechanical Contractor shall define and agree with the Engineer the responsibility for testing and pre-commissioning activities, i.e. whether the installer or the Commissioning Specialist is undertaking the activities. In some cases, the installer would undertake these activities and in this case, the Commissioning Specialist shall adopt an overseeing role to ensure the test results are satisfactory and all the pre-commissioning checks have been undertaken, documented and any remedial activities are undertaken to the satisfaction of the Engineer. Reference shall be made to all other sections of this specification, 'Standards Applicable' documents and the drawings to fully understand the scope of the overseeing role.

2C-11 COMPLIANCE WITH PART L OF THE BUILDING REGULATIONS

Part L of the Building Regulations is concerned with the conservation of fuel and power. All works approved under Part L of the Building Regulations shall be commissioned in accordance with the design intent. This applies to heating, ventilation, cooling / refrigeration, lighting, controls and hot & cold water systems. The Commissioning Specialist shall ensure that they are conversant with these Regulations, supporting Second Tier documents, and in particular the criterion that deals with the commissioning of the building services. The Commissioning Specialist shall ensure that they follow the guidance given in the approved procedure. They shall also provide a written notice to the Building Control Body that shall include a declaration confirming that:-

1) The commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard.

2) The results of tests confirm that the performance is sufficiently in accordance with the actual building designs, including written commentaries where excursions are proposed for acceptance.

2C-12 BUILDING LOG BOOK

A Building Logbook is required under Part L of the Building Regulations to ensure that the building uses no more power than is reasonable. The Main Contractor shall be responsible for the compilation and timely issue of this document to the building owner/ Client to enable them to manage the building's energy from the date of practical completion.

The Commissioning Specialist shall be responsible for the preparation, completion and timely handover of key elements of this document to the Mechanical Contractor. These include but are not limited to:-

1) Commissioning, handover and compliance

2) Metering, monitoring and targeting strategy

3) Building energy performance records

4) Relevant compliance and test certificates

It is essential that the Commissioning Specialist is conversant with the standard logbook template so they can provide the right level of information in the correct standard format and in a timely manner.

The Mechanical Contractor shall coordinate and obtain all other information necessary to complete the mechanical and electrical elements of the logbook. This includes but is not limited to obtaining information from the Engineer / Design Team, Electrical Contractor and Builder or Main Contractor. This must be programmed in and completed in advance of practical completion.

The logbook shall follow the standard format described within CIBSE TM31 and the guidance from the Carbon Trust which is illustrated within a CD as part of TM31. All information supplied to be incorporated within the logbook shall be provided both electronically and in hard copy.

The logbook shall make reference to other documents such as the O&M manual and the Health & Safety File. The completed logbook shall be issued in hard and electronic versions so that as a living document, it can be amended easily at a later date should it be required. It must be issued to the Main Contractor and Engineer for approval at least 2 weeks before practical completion.

2C-13 COMMISSIONING PROGRAMME

The Commissioning Specialist shall produce a detailed commissioning programme, which shall be fully integrated into the main contract construction programme. The commissioning programme shall be developed at the same time as the installation programme to ensure that the requirements for commissioning are incorporated in the construction activities.

The commissioning programme shall be broken down into individual services including sub-contract works and shall include but not be limited to the following tasks:

1) Review design drawings and specifications for commissioning requirements (commission-ability).

2) Review installation drawings and technical submissions for commissioning requirements.

3) Review the installation for compliance with specifications and drawings intent for commissioning.

4) Produce detailed commissioning method statements.

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5) Testing and pre-commissioning.
6) Off-site testing of plant items.
7) Pipework system cleaning and dosing.
8) Pressure testing of ductwork where applicable.
9) Setting to work of plant systems and commissioning and performance testing.
10) Open system scans.
11) Demonstration of flow rates to the Verification Specialist and Engineer.
12) Soak tests.
13) Prepare testing and commissioning reports.
14) Statutory demonstrations of life safety systems, to building end user and statutory authorities.
15) Prepare and complete the relevant sections of the building logbook.
16) Prepare final record documentation.
17) Prepare and submit the commissioning completeness notice to Building Control.
18) Training and awareness sessions with the building owner/ user.

The commissioning activities shall be fully co-ordinated within the programme by the Commissioning Specialist. The Commissioning Specialist shall indicate the resourcing requirements within the programme tasks. The programme shall show critical activities and milestones to enable focus to be maintained on these items in order to minimise the risk of delay. The commissioning programme shall be submitted to the Engineer no later than 6 weeks after the date of contract commencement, for approval. The dates involved shall be kept within the periods originally computed for testing and subsequently inserted as part of the 'Programme of Works'. Following completion and approval of this programme, the Commissioning Specialist shall review the programme in relation to the construction progress at the regular site attendance meetings. The testing shall proceed on the dates given but not less than 14 days following the notification to the Engineers of the state of readiness.

All Specialist Sub-Contractors and Specialist Suppliers to the Mechanical Contractor must note that they shall attend promptly on the times and dates stated. Failure to do so will result in the schedule being extended and any parties failing to attend shall be responsible for reimbursing the other parties involved for loss of time.

Notification of the testing programme commencement shall not be less than 14 days and no cancellations will be allowed.

2C-14 DESIGN FAMILIARISATION

Immediately following appointment and prior to works commencing on site, the Commissioning Specialist shall:-

1) Inspect the design drawings and this Specification in order to fully familiarise themselves with all the engineering services to be commissioned.
2) Be fully satisfied that all necessary provision has been made for commissioning of the services including items such as volume control dampers, commissioning stations and pressure stabilising valves, etc.
3) The Commissioning Specialist shall issue a report to the Engineer to include:-
   a) The details of any additional items that the Commissioning Specialist considers shall be included.
   b) Any further information needed to complete the installation.
   c) Detailed testing and commissioning program for the works.

2C-15 CONTRACTORS WORKING DRAWINGS

The Commissioning Specialist review the contractors working drawings as they are produced to ensure system is commissionable reviews to include:

1) Provision of sufficient measurement / regulation devices.
2) Location of regulation and measurement devices in terms of sufficient straight lengths for accurate readings.
3) Confirm flow rate through each device is within the accurate measuring range of said device.
4) Location of test points / test holes.
5) Location of BMS sensors where relevant (i.e. pressure transducers located correctly to achieve good readings).
6) Accessibility to regulation and control devices without obstruction from other services, structure or ceiling / boxing.
7) Adequate provision of access hatches in terms of size & location.

2C-16 SITE MEETINGS TO BE INITIATED

The Commissioning Specialist shall be required to attend monthly meetings from Contract Commencement to report on all stages of the commissioning, from initial planning / programming through to contract completion.

Two weeks prior to the first pre-commissioning activity, the Commissioning Specialist shall be required to commence attending weekly commissioning meetings, to report on the status of the commissioning, through to contract completion. The frequency of these meetings will be determined by the Engineer but the Contractor shall allow for weekly attendance.

The meetings shall be chaired by the Commissioning Specialist and the Mechanical Contractor shall attend with all their major Sub-Contractors.

The Engineer will not be present at any of these meetings but shall receive minutes of the same issued by the Commissioning Specialist.

2C-17 REVIEW SITE VISITS

During the installation of the contract works the Commissioning Specialist and the Mechanical Contractor shall visit site on a minimum basis of every two weeks to monitor the commission-ability of every aspect of the services in this Specification.

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This shall include ensuring that all commissioning stations are installed in accordance with the manufacturer's instructions and all other items are installed in accordance with the approved working drawings and are fully accessible.

Any aspect of non-compliance with the above shall be reported in writing to the Mechanical Contractor who shall carry out the necessary remedial work. Copies of all reports shall be issued to the Engineer.

During the site visits, the Commissioning Specialist shall carry out an audit of static testing of services to ensure that this work is being carried out satisfactorily. A written log of all static tests audited shall be kept for inspection by the Engineer.

As a part of the on-site inspections, the Commissioning Specialist shall ascertain that all aspects of the services can be fully maintained after handover. A report shall be issued to the Mechanical Contractor detailing any item that cannot be fully maintained and a copy of the report shall be issued to the Engineer.

2C-18 COMMISSIONING RECORDS & TEST SHEETS

The Commissioning Specialist shall ensure that accurate records are taken for all checks and measurements undertaken within the commissioning scope of works. The records shall be completed at the time of undertaking the commissioning activity and shall include any additional commentary that will support the understanding of the results, either later in the commissioning programme or in the future after the building has been in operation for some time. It is essential that this anecdotal information is included as it will help future fine tuning of the services and enable informed decisions to be made during building modifications and improvements.

Standard commissioning pro forma checklists shall be used to record the results. These shall be based on the criteria and templates in the relevant BSRIA Guides listed earlier in this specification. The Commissioning Specialist shall issue the proposed pro forma to the Engineer for approval prior to undertaking any testing. The completion of these pro forma shall be completed only once (i.e. not subsequently transcribed by typing since this can lead to errors being introduced).

The design of the pro forma shall be well thought out in order to:-

1) Aid the efficient execution of the commissioning tasks.
2) Help the control of quality and progress of the commissioning tasks.
3) Provide a convenient means of comparing test results within design values.
4) Serve as a permanent record of commissioning data to be included in the project's operating and maintenance manual.

2C-19 CALIBRATION OF INSTRUMENTS

The successful Commissioning Specialist must ensure that the instruments used have been correctly calibrated and produce documentation to this effect. Calibration must be carried out against laboratory standards which are either traceable to National Standards or have been derived by approved ratio techniques.

The calibration certificates shall include the following details:

1) Name of Calibration Laboratory.
2) Name of Equipment Manufacturer.
3) Equipment Model.
4) Serial Number of Equipment Being Calibrated.
5) Date of Manufacturer.
6) Date of Calibration.
7) Period of Validity of Calibration i.e. date for next re-calibration.
8) Deviation table where applicable.

If the Engineer has any doubt about the accuracy of any instrument, the Commissioning Specialist must have the instrument re-calibrated by a recognised Specialist.

A current calibration certificate shall be provided for all instruments used during the commissioning. The certificate must cover the duration for which the instrument is used.

Copies of these calibration certificates for all commissioning equipment used for each commissioned system shall be provided appended to relevant the commissioning sheets.

2C-20 METHOD STATEMENTS

The Commissioning Specialist and the Mechanical Contractor shall be responsible for compiling detailed commissioning method statements for all systems detailed in this Specification, this shall include obtaining method statements from all Commissioning Specialists and all suppliers of plant and equipment being installed on this contract, and amalgamating them into an overall method statement to provide a fully co-ordinated document for each service (including controls).

The document shall be sectionalised for each system to clearly indicate the work that will be carried out for pre-commissioning, commissioning and performance testing.

2C-21 INSPECTION OF MATERIALS

The Engineer shall be entitled at all reasonable times during the manufacture, to inspect, examine and test the materials and workmanship of all plant to be supplied under this Specification and if part of the said plant is being manufactured on other premises, the Mechanical Contractor shall obtain permission to inspect, examine and test as if the said plant were being manufactured on the Mechanical Contractor's premises.

Such inspection, examination or testing if made shall not absolve the Mechanical Contractor or release them from any obligation under this Specification.

Written notice shall be given to the Engineer of the date and the place any plant will be ready for testing. Notification of the test shall not be less than 14 days. The Engineer shall give a minimum 24 hour notice in writing of their intention to attend the tests. Such tests shall however, normally be attended solely by the Mechanical Contractor and their Commissioning Specialist, the Mechanical Contractor shall forward to the Engineer a report of the test and the test readings.

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Where the Specification requires for tests at outside premises, the Mechanical Contractor, except where otherwise specified, shall provide free of charge, such assistance, labour, materials, electricity, fuel, stores, oils and grease specified by the manufacturers, apparatus and instruments as may be required and as may be reasonable to carry out such tests efficiently.

If after inspecting, examining, or testing the plant, the Engineer decide that such plant or any part thereof is defective and not in accordance with the Specification, they may reject the said plant or any part thereof by giving, within reasonable time, notice in writing of such rejection stating therein the ground upon which the said decision is based. Normally the Commissioning Specialist shall filter out and resolve such problems without recourse to ask for advice from the Engineer.

At the commissioning and practical completion time of the Contract, all moving parts shall be adjusted and lubricated in accordance with the manufacturers' instructions, including the filling of oil wells, greasing of bearings, adjustment of belts, alignment of couplings, etc.

2C-22 FLUSHING AND CHEMICAL CLEANING

The Commissioning Specialist shall be responsible for ensuring that all pipework is flushed and chemically cleaned by others as detailed elsewhere in this Specification. The Commissioning Specialist shall supervise the flushing and cleaning of all services and be satisfied that all work is being carried out in accordance with the relevant governing documents and the 'Standards Applicable' listed in this Specification. The Commissioning Specialist shall issue a report to the Mechanical Contractor detailing any non-compliance with the above and a copy of the report shall be issued to the Engineer.

2C-23 TOLERANCES

All systems shall be regulated to tolerance bands to ensure that they meet the design intent.

Systems shall be commissioned in accordance with the tolerances detailed in the following table, except where more stringent requirements are detailed in the specific sections of this specification / drawings.

Where a tolerance is not defined in the Tender documents the levels within the CIBSE commissioning codes shall be used for tender and confirmed with the Engineer before commencing work.

Should the Commissioning Specialist be unclear of the performance effect (whether Low, Medium, High) of the systems within this specification then they shall seek advice from the Engineer.

The Commissioning Specialist shall consult the Engineer about acceptable tolerances for special process applications prior to the completion of the Mechanical Contractor's working drawings.

For a proportional balance to be achieved on water systems, the upper and lower tolerance levels shall not be exceeded. The index leg shall not be less than the minimum value and the remainder of the proportional balance shall be achieved within the overall tolerance and should aggregate to at least 100%.

The following table shows permissible tolerances for the most common applications for water and air systems. The Commissioning Codes W & A shall be referred to for all other applications. This table is to be read along with the associated notes and conditions of use within those Codes.

COMMISSIONING TOLERANCES		
	COMPONENT DESCRIPTION	FLOW RATE TOLERANCE (% DESIGN)
LTHW heating systems Performance effect - MEDIUM	Terminal units where flow rate <0.1 l/s (e.g. radiators & FCUs)	90 – 110%
	AHU coils where flow rate >0.1 l/s	92.5 – 107.5%
	Branches	92.5 – 107.5%
	Mains	100 – 110%
Chilled water systems Performance effect - MEDIUM	Terminal units where flow rate <0.1 l/s (e.g. FCUs & chilled beams)	95 – 105%
	AHU coils where flow rate >0.1 l/s	100 – 110%
	Branches	100 – 110%
	Mains	100 – 110%
Close Control Chilled water systems Performance effect - HIGH	Terminal units where flow rate <0.1 l/s (e.g. FCUs & chilled beams)	95 – 105%
	AHU coils where flow rate >0.1 l/s	100 – 110%
	Branches	100 – 110%
Air flow for general mechanical ventilation systems Performance effect - LOW	Terminals	95 – 110%
	Branches	95 – 110%
	Main Duct	95 – 110%
Air flow for peak temperature limiting and air conditioning systems Performance effect - MEDIUM	Terminals	100 – 110%
	Branches	100 – 110%
	Main Duct	100 – 110%
Air flow for close control systems, safety related systems and fume exhaust systems Performance effect - HIGH	Terminals	100 – 105%
	Branches	100 – 105%
	Main Duct	100 – 105%

2C-24 PRESSURE TESTING

The Mechanical Contractor and their Specialist Sub-Contractors shall undertake hydraulic and / or pneumatic pressure testing of pipework in accordance with the relevant 'Standards Applicable' and this Specification. The Commissioning Specialist shall review the testing method, check instrument calibration, witness the test and counter sign the test certificates. The Commissioning Specialist shall inform the Mechanical Contractor and the Engineer of any test failures. Following a test failure, they shall monitor the progress of any remedial work and the subsequent pressure tests until a satisfactory result is achieved.

2C-25 COMMISSIONING OF EQUIPMENT BY MANUFACTURERS

Specialist plant and equipment shall be inspected / commissioned by the manufacturer's competent person and a full commissioning report provided and included in the O&M documentation. The manufacturer shall commission the following:

1) All variable speed pumps
2) Air handling units / heat recovery units / ventilation plant.
3) Booster sets
4) Water treatment plant
5) Packaged domestic hot water generators
6) Refrigeration systems and all heat pumps including air to water air source heat pumps and VRV system.
7) Automatic controls and BMS
8) Energy metering by BMS as detailed in particular sections

The Commissioning Specialist shall include the commissioning period of all specialist plant and equipment within their plan and ensure that the coordination and timing of these activities fits in with the main commissioning programme and ultimately the construction programme. The Commissioning Specialist shall obtain the commissioning report and verify that all the checks have been completed and signed off with the system being safe prior to setting them to work as part of the overall building services systems.

The Mechanical Contractor shall inform the Commissioning Specialist of the divisions of responsibility between specialist plant manufacturers and the Commissioning Specialist when it comes to commissioning that plant.

2C-26 OPEN SYSTEM SCAN

An open system scan shall be undertaken prior to the regulation and balancing of all air and water distribution systems. The results shall be recorded and any irregularities rectified prior to adjusting dampers, regulating valves, fan and pump duties. Under no circumstances shall dampers or valves be regulated to rectify any significant under or over volumetric readings.

2C-27 DOCUMENTATION FOR OPERATING AND MAINTENANCE MANUALS

The Commissioning Specialist shall be responsible for providing the documentation listed below for inclusion in the operating and maintenance documentation:-

1) Fully signed master and copies of all commissioning records and test sheets as detailed earlier in this Specification (hard copy and PDF).
2) Details of any amendments to the installed plant and equipment (e.g. changes to belt and pulley sizes).
3) Details of any off site test sheets as detailed earlier in this Specification.
4) The Commissioning Specialist shall be responsible for programming the progress of compilation of record drawings and manuals and shall ensure these are completed in their entirety PRIOR to handover and Practical Completion.

2C-28 LIAISON WITH STATUTORY AUTHORITIES

The Commissioning Specialist shall arrange all necessary liaison with the statutory authorities as appropriate. This shall include but not be limited to the Building Control Officer and the Fire Advisor. The statutory authorities shall carry out all the required witnessing of the completed systems prior to their handover to the Client.

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Section Two (D)

General Installation Clauses - Thermal Insulation

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2D-1 GENERAL REQUIREMENTS

2D-1-1 INTRODUCTION

The Contractor shall employ a Specialist Contractor(s) to undertake the Thermal insulation work. The Specialist Contractor(s) shall be registered with the Thermal Insulation Contractors Association (TICA) and all employees carrying out any part of the installations shall be TICA 'Experienced Worker Card', 'Skilled Worker Card', 'Advanced Craft' or 'Supervisor Card' holders.

The Specialist Contractor(s) shall include for all materials, labour and other incidentals (e.g. off-loading, dry site storage, etc.), necessary to satisfactorily install and complete the insulation works. The Contractor shall state, at the time of tendering in the Specification Tender Analysis, the name of the Insulation Specialist Contractor(s) who shall carry out the work.

Alterations / changes of Insulation Specialist Contractor(s) to those listed in the Tender Return, shall not be accepted without prior agreement by the Engineer after documented evidence giving reasons for change has been received.

The Contractor shall submit an itemised schedule of rates for the insulation works including all types and finishes being used in the Contract.

EXTERNAL HORIZONTAL DUCTWORK

Horizontal ductwork located externally shall be provided with a sloping top to prevent rainwater from collecting / pooling on the top finish.

2D-1-2 DEFINITIONS

Refer to the definitions contained within the BESA TR series of documents and the following:

REFERENCE	DESCRIPTION	REFERENCE	DESCRIPTION
ACAD	Asbestos Control and Abatement Division	MTHW	Medium Temperature Hot Water
ACoP	Approved Code of Practice	N/A	Not applicable / Not permitted
BCWS	Boosted Cold Water Service	NDBSCG	Non-Domestic Building Services Compliance Guide
BEIS	(Department for) Business, Energy and Industrial Strategy	ODP	Ozone Depletion Potential
CHW	Chilled Water Service	SCC	Stress Corrosion Cracking
CLP	Classification, Labelling and Packaging Regulation	SS	Stainless Steel
DHWS	Domestic Hot Water Service	TCWS	Tank Cold Water Service
ETL	Energy Technology List	TICA	Thermal Insulation Contractors Association
GWP	Global warming potential	TIMSA	Thermal Insulation Manufacturers and Suppliers Association
HTHW	High Temperature Hot Water	WRAS	Water Research Advisory Service
LTHW	Low Temperature Hot Water	VOC	Volatile Organic Compounds
MCWS	Mains Cold Water Service		

CODE	MATERIAL	TEMP RANGE	'λ' VALUE AT 10MM AT MEAN TEMP °C
CS	Calcium silicate	150°C to 650°C	As listed in thickness tables
FEF	Factory made flexible elastomeric foam (Closed-cell – Class 0)	5°C to +105°C (or +85°C if sheet or tape is glued to the object with its whole surface)	As listed in thickness tables
MW	Mineral Wool	-40°C to +300°C	As listed in thickness tables
PF	CFC-free phenolic resin (foam) insulation	-40°C to +100°C	As listed in thickness tables

2D-1-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification describes requirements for the Thermal Insulation of building services installation and shall not be used in isolation. It must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the Thermal insulation installations.

2D-1-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

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STANDARDS	
BESA DW 144 Sheet Metal Ductwork	BS EN 13941 Pre-insulated bonded pipe systems for district heating
BRE Green guide to specification	BS EN 14303 Thermal insulation products for building equipment and industrial installations. Factory made mineral wool (MW) products. Specification.
BS 476 Fire tests on building materials and structures	BS EN 14304 Thermal insulation products for building equipment and industrial installations. Factory made flexible elastomeric foam (FEF) products. Specification.
BS 1710 Specification for identification of pipeline & services	BS EN 14305 Thermal insulation products for building equipment and industrial installations. Factory made cellular glass (CG) products. Specification.
BS 3533 Glossary of thermal insulation terms	BS EN 14306 Thermal insulation products for building equipment and industrial installations. Factory made calcium silicate (CS) products. Specification.
BS 3958 Thermal insulating materials	BS EN 14314 Thermal insulation products for building equipment and industrial installations. Factory made phenolic foam (PF) products. Specification.
BS 4508 Thermally insulated underground pipelines	Carbon Trust Pipework insulation equipment
BS 5422 Method for specifying thermal insulating materials	ESS SD 5073 BREEAM new construction non-domestic building technical manual
BS 5615 Specification for insulating Jackets for domestic hot water storage cylinders	Non-Domestic Building Services Compliance Guide
BS 5970 Thermal insulation of pipework and ductwork	TIMSA / TICA documents including Guidance for achieving compliance with Part L of the Building Regulations
BS 8313 Accommodation of building services in ducts	
Note on BS 5422 and Energy Technology List **The insulation thicknesses listed in BS5422 are insufficient to achieve compliance with the standards of the Energy Technology List. All insulation thicknesses listed in this section of the specification are provided to meet minimum requirements of the Energy Technology List.**	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2D-1-5 SCOPE

This section describes the thermal insulating materials, coverings (including protective coverings) and installation applied to engineering services.

It excludes sound insulation, chimney, boiler or cold room insulation and insulation of the structure. These requirements will be specified elsewhere, if necessary. Should these excluded insulations be required they shall be described within the specific clauses.

The thickness and finishes of insulation detailed within this Specification are the minimum standard acceptable.

The requirements of ISO 9000 and Thermal Insulation Manufacturers and Suppliers Association (TIMSA) guidance for achieving compliance with Part L of the Building Regulations, including all Second Tier Documents, shall be also apply.

Should any discrepancies become apparent, the most onerous requirement shall be employed.

Preformed/ pre-moulded bends, flanges and valve covers to the respective requirements above (thicknesses same as the pipework) may be used: the overall finish/ covering to be the same as the adjacent pipework.

2D-1-6 SERVICES TO BE INSULATED

Thermal insulation shall be applied to:

- Complete heating systems, including pipework, pipework supports, calorifiers, buffer vessels, feeds and vents, etc., but excluding any pipework or any final connections that are so located and designed as to usefully contribute heat to the space without causing uncontrolled overheating. The room located heat emitters, such as pipe coils, shall not be thermally insulated.
- Complete domestic hot and cold water service systems, including calorifiers, cylinders, storage cisterns / tanks, all flow and return distribution pipework, pipework supports, thermostatic mixing valves and all blended water pipes except for short sections, maximum of 300mm long, of final connections to draw-off points where there is insufficient space to separately insulate hot and cold water pipes. Where these pipes are concealed, in integrated plumbing systems (IPS), in cupboards or otherwise concealed from general user view the pipes shall be fully insulated.

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- Large internal and external cold water storage cisterns shall be insulated fully in accordance with WRAS Regulations and shall be certified as being WRAS Approved. Any additional insulation requirements shall be detailed in the specific clauses of this specification.
- Buried water pipes, which rise within 750mm of the outside wall of the building – fully in accordance with WRAS Water Regulations Guide.
- Entire pipework, pipework supports, pumps and vessels, etc. in heat recovery systems.
- Direct Expansion (DX) refrigeration systems throughout. Externally located insulation shall be weather-proof with factory applied ultraviolet radiation protective coating.
- Safety valve discharge pipes for steam, heating and hot water. These pipes shall be fully insulated throughout even if this is not a requirement under the British Standard.
- Supply air handling plant including heater or cooler batteries and intake ductwork to plant, insulated and then vapour sealed to prevent condensation.
- Ductwork carrying heated, cooled, tempered or conditioned supply air or extracted air for re-use by recirculation or for extracted air forming part of a heat recovery system.
- Air extract ducting to atmosphere - where such ducting passes through occupied areas and contributes to the heat gain / loss of the occupied area.
- Any pipework with heated / cold / chilled fluid, within hollow partition, "boxed-in, floor screeds, concealed and all pipework subject to potential frost conditions.
- Where heat loss or heat gain to any system or part of a system reduces overall system energy efficiency of an installation.

Any thermal insulation requirements in addition to those detailed above shall be detailed in the specific clauses of this specification.

2D-1-7 PIPEWORK CLEARANCES

It is imperative that there is a minimum of a 25mm clearance all round a completed insulated pipe to enable the insulation to be applied and properly sealed. It is therefore necessary to consider the insulation thickness early in pipework design. Failure to comply with this requirement will require the Contractor to remove newly installed pipework and re-install at their cost.

The Contractor shall leave sufficient clearance between each pipe / service to allow for the thickness of insulation specified in the tables of this section and to give good maintenance access between insulated services.

Where possible, hot water and heating pipes shall be located above cold water and chilled water pipes to minimise heat transfer.

Additional space / clearance may be required where insulated pipe sleeves are used. Examples of such systems shall be steam, condensate, cold and chilled water services.

Necessary consideration shall be given to the fixing lobes located on both sides of the pipe support bracket to avoid clashes.

2D-1-8 ALTERNATIVE MAKES

The use of other forms of insulation, or other manufacturer's products, may be considered provided they comply fully with the requirements laid down in this Specification.

This applies to insulation such as flexible Class 0 rated black flexible elastomeric foam which may be used in confined spaces e.g. between partitions or where plastic pipes are proposed to be continuously supported on cable trays where the hot and cold water pipes are adequately separated to avoid heat transfer between fluids (i.e. the hot water pipes warming the cold water pipes).

They shall also be subject to the approval of the Engineer before including within the tender return, ordering or installing; at least one month's notice is required for approval.

2D-1-9 AVAILABILITY OF MATERIALS

Insulation thickness specified may not always be stock items. Delays to the contract due to lack of or poor availability of materials, etc. shall not be accepted. To avoid delay, the Contractor shall utilise the nearest greater thickness insulation, at no additional cost to the contract.

2D-2 MATERIALS

2D-2-1 GENERAL

All insulation materials shall be:

1) New, clean and undamaged.
2) Totally free of asbestos.
3) Obtained, where available, from a BS EN ISO 9001: 2015 'Quality Systems' certified manufacturer.
4) CFC, HFC and HCFC free with a zero ODP and GWP of less than five (number 5).
5) Rot proof, non-hygroscopic, free from animal hair, VOC's or settling under vibration and resistance to attack and damage by vermin and to the growth of fungi.
6) Provided with fully sealed weather-proof and waterproof quality finish for outdoor (external) situations.
7) Fully resistant from Ultraviolet Radiation degradation, this particularly applies to flexible elastomeric foam and rubber insulation used for refrigeration pipework, which is required to have a factory applied UV coating protection to avoid this issue.
8) So protected, manufactured, constructed and installed to prevent electrolytic action, corrosion or decay.
9) Durable and shall maintain their installed thermal conductivity (λ - value) for the expected life of the installation.
10) Free from objectionable odours at their temperature range band.
11) Free of chemicals that may contribute to corrosion of the insulated surface or surface finish.

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12) Delivered to site new and fully dry, stored and maintained throughout the Contract. Damp or wet insulation, even if dried out, shall not be used.

13) The relevant certification undertaken in line with the required EU method, indicating that fibres are not classified under the CHIP 98 Regulations and EU Directive 97/69/EC.

14) Responsibly sourced. Include all evidence provided to BREEAM assessors, where applicable.

15) Low embodied impact relevant to their thermal properties determined by the Green Guide by achieving either A or A+ Green Guide rating.

16) Installed fully in accordance with the best practice recommendations of the thermal insulation manufacturer and pipework manufacturer if specialist pipework systems are installed (for example - any press fit stainless steel system).

17) Entirely suitable for the actual installation.

18) Be CE marked in accordance with the relevant standard that the insulation has been manufactured.

19) Factory Mutual approved to Approval Standard FM 4924.

Insulation material shall only be installed as follows:

1) Only once all external surfaces of pipes and ducts have been cleaned and free from all dust, cement, plaster, etc. All traces of surplus flux shall be completely removed from the surface of copper pipework.

2) Where recommended by the pipework material manufacturer an impermeable barrier shall be installed between the pipework and the thermal insulation.

3) Installations shall ensure that any protective fixings do not penetrate the vapour barrier (e.g. not use pop rivets on Aluminium sheeting unless adequate clearance).

4) Applied to individual pipes or ducts. Adjacent parallel pipes or ducts shall not be married together with one common insulation covering unless specifically detailed on the drawings or specifications e.g. trace heating/ fuel oil.

5) Only after the particular service installation section has been successfully pressure tested.

6) Only after steel pipework painting has been completed by the Contractor.

7) Identified as detailed elsewhere in this specification.

8) When exposed to view internally or externally (excluding plant areas) and below 2 metres from finished floor level, complete with mechanical protection.

9) All insulation within plant areas shall be complete with mechanical protection.

Insulation shall NOT:

1) Be bonded (nor any covering) by any adhesive, sealant or banding which may cause a fire hazard or emit dense smoke or toxic fumes, if subjected to excessive heat such as in a fire.

2) Suffer deterioration at the maximum temperature under the specified conditions of use.

3) Suffer permanent deterioration as a result of contact with moisture due to condensation or other sources.

4) Be supported on wood, cork or polystyrene etc., blocks or segments used as insulating pads / collars.

5) Be applied to condensate cooling legs.

6) Be 'classified' under the CLP Regulations.

7) Have adhesive tapes applied to any pipes themselves, specifically at ends of pipe to 'neaten' or 'tidy' the appearance of the installation. Proprietary end caps of the same material as the rest of the finish shall be used.

Damage Limitation

Insulation and protective coverings shall be:

1) Protected during the progress of the works.

2) Maintained dry as appropriate.

3) Fabricated to allow for expansion, contraction, ease of access for maintenance, testing, operation or replacement of equipment without damage to the service or insulation,

4) Protected against mechanical damage where run exposed on the surface in vulnerable areas, e.g. an installation at low level in a corridor, which may be subject to impact by cleaning machines, trolleys, etc.

5) Only applied after the building is weather tight to avoid risk of rain, snow or ice damaging the thermal insulation.

6) Installed so that the protective covering does not damage or penetrate the vapour barrier of the thermal insulation.

The Specialist shall take appropriate steps to prevent damage to new and existing pipework, ductwork and plant, etc., throughout the progress of the works. This requirement shall also apply to new and existing insulation of services. Any damage shall be rectified at no additional cost to the Contract and to the satisfaction of the Engineer.

2D-2-2 INSTALLATION REQUIREMENTS

The Insulation Specialist Contractor shall:

- Provide proof, prior to installation, to the Site Engineer, Clerk of Works that the insulation proposed complies with this specification and is of the correct thickness, thermal conductivity, fire rating and density of insulation as required in this Specification and relevant ISO/ British Standards. Insulation installed and not complying with these requirements shall be removed and replaced with new insulation to the requirements, all at the Contractor's own expense with no impact on the contract cost or programme completion date.
- To minimise risks of stress corrosion cracking of stainless steel pipework, irrespective of proposed thermal insulation, pure aluminium foil of minimum thickness 0.06mm shall be applied to any stainless steel pipework, including under pipework supports, that is externally located, may be subject to rainfall, trace heated or otherwise at risk of SCC prior to insulating to protect against chloride induced corrosion of the surface as recommended by the British Stainless Steel Association, British Standards, thermal insulation and pipe manufacturer's best practice recommendations.

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- Ensure that all insulation is firmly secured in accordance with the manufacturer's recommendations. e.g. with bands of 50mm reinforced aluminium foil adhesive tape, 25mm MS black lacquered bands, 20mm lightweight aluminium bands, insulation hanger pins and washers; at not greater than 400mm equidistant centres or closer if recommended by the product manufacturer. This requirement exists to maximise the appearance and life expectancy of the installation.
- Apply the insulation strictly in accordance with the insulation manufacturer's recommendations and instructions; work done failing to comply shall not be accepted.
- Ensure that all insulation is applied to provide a neat, smooth and symmetrical appearance, running true in line with pipe or duct distribution.
- All unused insulation, finishes and packaging, etc., shall be removed from the site before the final acceptance of the works. All fibrous particles remaining after cutting and fabrication shall be removed by suction cleaning at the end of the working day.
- The Contractor shall be responsible for the insulation installations until practical completion (partial or full). Any damage, poor quality, irregular, badly finished or installed insulation and/ or surfaces shall be made good at the Contractor's expense, so that the installed insulation is handed over in perfect condition.
- Upon completion of the installation, the Engineer may request one section of the insulation on each of the services to be cut out to allow for verification of the thickness and/ or density. The Contractor shall allow to undertake the cut out and reinstatement of the insulation at their own expense.
- If defects are revealed, cut out two further sections of suspect insulation for inspection.
- If further defects are revealed, remove the whole of the installation and provide and fix new insulation to the satisfaction of the Engineer at the Contractor's own expense.

2D-2-3 USE OF PHENOLIC FOAM

Phenolic foam insulation **shall not** be used on:

- Domestic cold water systems for copper pipework installations..

The above requirements are mandatory unless stated otherwise under the specific clause sections of this specification.

2D-2-4 PHENOLIC FOAM INSULATION PERMITTED USE

Where the use of Phenolic foam has been agreed, the insulation shall then only be installed as stated below.

Phenolic Foam insulation is acceptable only in the following situations:

- All phenolic foam shall be of a CFC (and/ or HFC, HCFC) free type.
- Bore coated preformed pipe sections having a 25 year aged thermal conductivity of 0.025W/m k at 10ºC mean temperature in accordance with the listed standard.
- Have a factory applied Class 0 reinforced aluminium foil jacket.
- Certification shall be provided.

Where phenolic foam is used on copper and stainless steel pipework, the Specialist Contractor shall additionally:

- Ensure that the phenolic foam pipe insulation is bore-coated (impregnated) with a factory applied passive anti-corrosive agent (as minimum specification for phenolic sections).
- Completely wipe clean all external pipe surfaces to remove all moisture and building materials, dust, surplus soldering jointing flux, etc. immediately prior to applying insulation.
- Cover the copper pipework and fittings with a coating of anti-corrosive gel, e.g. DENSO paste or equivalent. Alternatively a non-metallic plastic tape may be wrapped around all pipework provided it meets the manufacturer's approval.
- Install insulation to the manufacturer's recommendations, method statement and British Standards.
- Ensure any aluminium foil over wrap does not make contact with any copper pipework.
- Ensure the vapour barrier is continuous and unbroken. All terminations/ protrusions through the installation shall be vapour sealed.
- Ensure the correct bore insulated sections are used to suit the overall diameter of the pipework being insulated.
- The Specialist Contractor shall liaise with the Contractor to ensure that pipework is installed on insulated pipe supports.
- Ensure that the insulation cannot become wet or waterlogged, with particular care on any external installations where the outer protective covering shall be fully weather / waterproof, the vapour barrier alone shall not be relied upon.

2D-2-5 FIRE PERFORMANCE

The insulation and its covering/ finish shall have a Class 1 rating, minimum to BS 476-6, and be classified Class 0 in accordance with The Building Regulations Approved Document B (Current Edition) Appendix A and current amendments.

All thermal insulation and protective coverings shall meet the requirements of BS 5422 when tested in accordance with BS 476.

Where located in cavities, of a class required by Current Building Regulations, Approved Document B, Appendix A.

Where located in rooms, circulation spaces and protected shafts, of a class equal to the class for walls in Building Regulations, Approved Document B, appendix A. Table 1A.

Class 1 shall be construed and tested in accordance with Building Regulations, Approved Document B, Appendix Tables 7 & 8

Under no circumstances shall insulation be carried through fire compartment walls or floors unless the detail / installation complies with the current Building Regulations. Fire stop unit(s) as required by the Building Regulations, Approved Document B, wherever the services perforate a compartment wall or floor designed as a fire barrier shall be used. The requirements of BS 476 shall also be complied with.

The above requirement shall apply to all insulated ventilation ductwork except for fire barriers where fire dampers are used.

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Attention is drawn to the risk attached to the use of PVC, PIB, foamed rubber, polyurethane, polystyrene or isocyanurate, etc. Even where these materials are claimed to be fire resistant and / or self-extinguishing, they have proven in the past to be highly combustible and produce toxic smoke causing a hazard to personnel.

Foamed rubber, polyurethane, polystyrene, isocyanurate or similar types of insulation/finish **shall not** be used.

2D-2-6 BUILDING REGULATIONS

TIMSA guidance for achieving compliance with Part L of the Building Regulations also includes measures to prevent condensation and provide frost protection and shall be complied with as a minimum standard.

2D-2-7 ELECTRICAL BONDING

Where insulation with a sheet metal surface finish is used, e.g. aluminium stucco sheeting, etc., it shall comply with IET Regulations, as regards the facility to be electrically bonded to a protective conductor.

Bonding shall be carried out by the Electrical Contractor but the connections shall be included for by the Contractor in their tender. Insulation of pipework, ductwork or plant, finished with aluminium or other metal (accept aluminium foil) shall be bonded.

To ensure electrical continuity, all metal surface finish insulation shall be bonded and earthed in accordance with BS EN standard using stainless steel wire or bands as specified in BS 5422.

2D-3 INSULATION OF SUPPORTS

All steam, condensate, LTHW, MTHW, HTHW, domestic hot, domestic cold, chilled water, refrigeration pipework, condenser water and any other pipes that are thermally insulated shall be fitted with insulated supports whereby the insulation is continuous and not punctured.

Cold feeds, vents and safety valve discharges, although they may be insulated do not need insulated supports. Gas pipework is not insulated and therefore does not require insulated pipe supports.

All pipe supports shall have a rated density in accordance with the manufacturer's recommendations for the pipe diameter.

All pipe supports shall be the same thickness as the pipe thermal insulation to provide a continuous neat sealed appearance.

Insulated pipework supports for mineral wool insulation shall be phenolic, where permitted and up to 100°C or calcium silicate or Foamglas One above 100°C, to the higher load bearing necessary based on pipe sizes and support centres, due to equivalent insulated block supports not being available in mineral wool form. Where this is the case, the insulated blocks shall be to the same thickness and finish as the adjacent mineral wool pipework.

Where phenolic blocks are proposed to be installed on copper pipework, the Contractor shall install a layer of 0.25mm thick polythene sheet or pipework (not electrical insulation) PVC tape wrapped around the pipe so that 50mm exposed tape or sheet is visible either side of the support blocks on both sides to provide an additional vapour barrier between the block and the pipework.

Suitable PVC tapes for this purpose are as provided by Advance Tapes International Limited (+44116 251 0191), range AT10 PVC Heavy Duty Pipe wrap Tape or Directa (UK) Limited (+441621 828882) PVC Heavy Duty Pipe Wrap Insulation Tape.

This additional requirement only applies to cold water, chilled water pipework systems and any system where the fluid is below 50°C where phenolic blocks are used on copper pipework. Note – Stainless steel pipes are required to be wrapped in aluminium foil to minimise risk of SCC as detailed earlier.

The insulated supports shall have a "λ" value not exceeding 0.065 W/mK, be a minimum of 50mm wider than the pipe clip or duct bracket and of a corresponding thickness to that specified for the service. The whole section shall be encased in a reinforced sleeve (GRP or MS galvanised) of greater length then the isolating load bearing section of insulation.

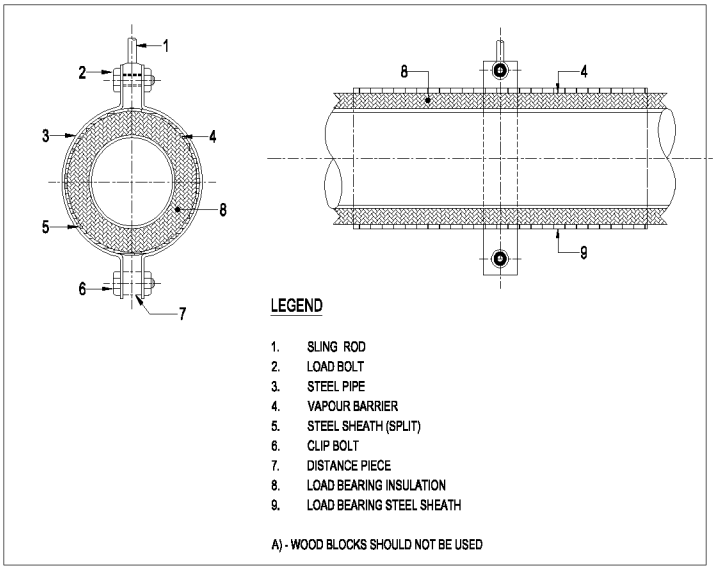
The installation shall be as outlined in BS 5970, except that wood and cork shall not be permitted even when listed or mentioned in BS 5970. In summary, hard wood, cork or polystyrene blocks or segments as an insulating pad or collar are NOT acceptable.

All insulated pipe supports shall follow the preferred principle detailed in BS 5970 Figure 12 'Preferred Option – hanger incorporating load bearing insulation (for pipes operating above and below ambient temperature' where the pipe bracket is around the outside of both the insulation and vapour barrier. BS 5970 figure 18 provides details of 'Typical proprietary support inserts' that meet the overall insulated pipe support requirement.

On rare occasions, and only after written permission has been received from the Engineer, will pipe supports in direct contact with the pipe as detailed in BS 5970 figure 13 'Non-preferred option – hanger incorporating load bearing insulation (for pipes operating above and below ambient temperature' be accepted.

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PREFERRED OPTION - HANGER INCORPORATING LOAD- BEARING INSULATION (FOR PIPES OPERATING ABOVE OR BELOW AMBIENT TEMPERATURE) A)

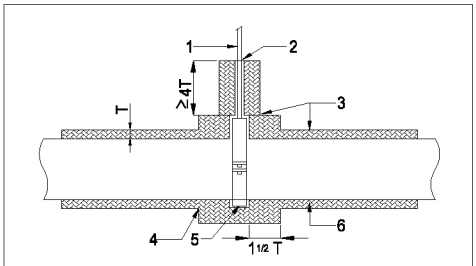


LEGEND

1. SLING ROD
2. LOAD BOLT
3. STEEL PIPE
4. VAPOUR BARRIER
5. STEEL SHEATH (SPLIT)
6. CLIP BOLT
7. DISTANCE PIECE
8. LOAD BEARING INSULATION
9. LOAD BEARING STEEL SHEATH

A) - WOOD BLOCKS SHOULD NOT BE USED

NON PREFERRED OPTION - HANGER IN DIRECT CONTACT WITH PIPE (NOT FOR PIPES OPERATING BELOW AMBIENT TEMPERATURE) A)



LEGEND

1. HANGER ROD
2. FLASH FINISH AROUND HANGER ROD
3. FINISH
4. HEAVY FILLET OF CAULKING MASTIC
5. FLEXIBLE
6. INSULATION

A) - WOOD BLOCKS SHOULD NOT BE USED

The insulated supports for pipes and ductwork shall be manufactured by:

- Kingspan Industrial Insulation Limited - Kooltherm range.
- Foamglas One (previously T4).
- Any calcium silicate supplier agreed with the engineer when required to use calcium silicate supports.
- Any equivalent manufacturers who complies with the above requirements and is agreed with the engineer.

All pipe support inserts must be load bearing type.
For 40mm nominal bore pipework and above all phenolic pipe supports should include an integral spreader plate.

Supports for insulated circular (V-slots strips) and rectangular ductwork (flat strips) shall be structural 120kg/m^3 phenolic foam (or a lower density if calculated for the specific load and calculations are agreed with the engineer) of the same thickness as the proposed thermal insulation.

2D-4 PROTECTION AND PROTECTIVE COVERING

2D-4-1 INTERNAL APPLICATIONS - GENERALLY

For general distribution on pipework and ductwork aluminium foil laminate: Factory applied reinforced aluminium foil laminate to achieve a Class 0 fire rating.

Where longitudinal joint overlaps are provided, the overlap shall be at least 50mm, with a factory applied seating strip. Otherwise longitudinal and circumferential joints shall be sealed with matching self-adhesive, Class 0 foil tape not less than 50mm wide.

Foil finish and foil tape shall not come into contact with any pipework surface, such that electrolytic corrosion is avoided.

2D-4-2 INTERNAL APPLICATIONS - PLANTROOMS, BOILER HOUSES

Aluminium sheet or steel sheet with aluminium and zinc coating (minimum thickness as below) secured with aluminium bands, 'pop' rivets or self-tapping screws at 50mm pitch, end joints covered with 75mm wide aluminium strip and purpose made aluminium caps.

Plain or Stucco (hammered) finish as agreed with the Design Engineer.

All joints shall be sealed with a suitable coloured sealant when a vapour barrier is required. Overlap on longitudinal joints shall be 50mm minimum. Heat bridges between the hot surfaces and the metal casings are not acceptable. Aluminium finish is not to come into contact with any pipework surface, such that electrolytic corrosion is avoided.

On cold services, care shall be taken to avoid puncturing the insulation vapour barrier jacket with rivets or screws.

THICKNESS OF ALUMINIUM/STEEL PROTECTIVE COVERING	
INSULATION OD (MM)	FLAT SHEET PLAIN OR STUCCO FINISH (MM)
Up to 150 151 to 450	0.7 (1.2) see note 0.9 (1.2) see note
Above 450 and flat	1.2 (1.9) see note
Note: The thickness shown in brackets are shall be used where damage by impact is likely to occur	

2D-4-3 EXTERNAL APPLICATIONS - ALL SERVICES EXPOSED OR IN NON-WEATHERTIGHT DUCTS, RISERS ETC

All external services coverings shall be:

1) Where service distribution systems and plant are exposed to view:
   a) Plastisol coated sheet steel, minimum thickness of 1mm, protective covering all in accordance manufacturer's installation best practice recommendations for external installation.
   b) Final colour to blend in with building structure and as agreed with Architect.
2) Where services distribution systems and plant not visible:
   a) Flat sheet plain or Stucco aluminium sheet as described for plant rooms and boiler houses. All joints fully waterproofed in accordance with the manufacturer's best practice recommendations.
3) For all closed-cell flexible elastomeric foam insulation (e.g. Armaflex) where the surface of the material is exposed to water, sunlight, UV radiation or attack by aggressive chemicals it shall be:
   a) Preferred solution of using UV-resistant Armacell Armaflex Tuffcoat /, Kaiflex EPDM plus or approved equivalent to be agreed with the Engineer.
   b) Protected using a proprietary paint finish, i.e. Armacell Armafinish 99 paint, applied strictly in accordance with the manufacturer's recommendations. A minimum of two coats shall be applied with the second coat within 3 days of the first.
   c) If additional mechanical protection or protection against severe weather conditions is required, Arma-Chek R covering systems offer a non-metallic cladding option. This will be stated within the particular sections of this specification if required.
4) Horizontal runs of ductwork that are exposed to rain shall be finished with a sloping top to prevent rainwater from pooling on the ductwork finish. The slope on the top of the ductwork shall be achieved using tapered thermal insulation that fully complies with the insulation thicknesses detailed in this specification.

2D-4-4 BURIED SERVICES

1) Where services distribution systems and plant are within trenches:
   a) The insulation shall be protected by an outer rigid pipe to prevent the insulation being crushed and losing its effective thickness.
   b) When buried where it will be in wet or moist ground for long periods, then the sealed material is to be wrapped in a reinforced plastic or waterproof tape, e.g. Denso tape, Fibaroll or approved equivalent to be agreed with the Engineer, prior to being protected by an outer rigid pipe.
   c) Any pipework installed in pre-insulated pipework system shall be in accordance with BS EN 13941 complete with leak detection systems.
   d) Refer to Specific sections of this specification for installation details.

2D-4-5 ALTERNATIVE COVERINGS

Materials described under clauses 2D4-1 to 2D4-4 inclusive are the default standards required under this specification.

Where specifically stated in the particular clauses of this specification or if the Contractor is requested through the tendering process to provide 'Value Engineering' options the following materials will be considered as acceptable:

2D-4-5-1 INTERNAL APPLICATIONS - PVC SHEET

PVC sheet shall be a minimum thickness of 0.35mm and applied with a minimum overlap (lengthways and in circumference) of 30mm. All joints to be secured with plastic push in rivets or special solvent based adhesive. Purpose made cap-ends to pipework shall be provided and the complete installation shall be in accordance with manufacturer's recommendations.

The PVC sheet shall be:

- Suitable for installation within a temperature range of –20°C to 65°C
- Thermal conductivity – 0.16 W/mK
- Impact strength - >400 kJ/m^2
- Tensile Strength - >35 N/mm^2
- Fire rated Class 1 to BS476
- Colour – Grey (to be confirmed with Architect)
- Manufacturer – Isogenopak or as agreed in writing by the Engineer

2D-4-5-2 INTERNAL APPLICATIONS - SYNTHETIC SHEET

Synthetic sheet shall be a self-adhesive 6-ply laminar construction providing a continuous vapour barrier and applied with a minimum overlap of 75mm. All joints to be secured with 'Proclad T' tape for pipework and using Proclad recommended tap for ductwork. All tapes shall be selected to match the sheet covering. Purpose made cap-ends to pipework or ductwork shall be provided. The complete installation shall be in accordance with manufacturer's recommendations.

The synthetic sheet shall be:

- Suitable for installation within a temperature range of -40°C to 140°C,
- Provide zero permeability and continuous vapour barrier,
- Puncture Resistance – >100N,
- Tensile Strength – >200N,
- Water permeability – 0.0000 perms (absolute vapour barrier),
- Fire rated Class 0 to BS 476 parts 6 & 7,
- Mould resistant,
- Colour – White / Black / Silver / Silver Embossed (similar to Aliclad appearance) (**Colour to be agreed with Architect**)

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- Manufacturer – Proclad 'Proclad 150'.
- Contact information - www.protechglobal.co.uk

These synthetic sheets shall not be used where mechanical protection is required.

2D-4-5-3 EXTERNAL APPLICATIONS - SYNTHETIC SHEET

Synthetic sheet shall be a self-adhesive 'ProClad Plus' jacketing system providing a continuous vapour barrier and applied with a minimum overlap of 75mm. All joints to be secured with 'Proclad Plus 4-layer' tape (selected to match the sheet covering), purposed made cap ends to pipework or ductwork shall be provided and the complete installation shall be in accordance with manufacturer's recommendations.

The Contractor shall note that the externally located synthetic sheet is required to be 'Proclad Plus', the sheet thicknesses shall be as follows:

THICKNESS OF 'PROCLAD PLUS' PROTECTIVE COVERING	
INSULATION OUTER DIMENSION (MM)	FLAT SHEET PLAIN OR STUCCO FINISH (MM)
Up to 150mm	280 microns (0.28mm)
151mm to 450mm	340 microns (0.34mm)
Above 450mm and flat surfaces	450 microns (0.45mm)

The thinner 6-ply sheeting shall not be used externally – this shall be verified during the installation and failure to install the thicker sheet externally shall require the entire external finish to be replaced to comply with this requirement at no cost to the contract.

The synthetic sheet shall be:

- Suitable for installation within a temperature range of -40°C to 120°C,
- Provide zero permeability and continuous vapour barrier,
- Puncture resistance – 110N,
- Tensile strength – >285N/15mm,
- Fire rated Class 0 to BS 476 parts 6 & 7,
- Mould resistant,
- Colour – White / Black / Silver / Silver Embossed (similar to Aliclad appearance) (**Colour to be agreed with Architect**)
- Manufacturer – Proclad 'Proclad Plus'.
- Contact information - www.protechglobal.co.uk

2D-5 VAPOUR BARRIERS FOR REFRIGERATION, DOMESTIC COLD, CHILLED WATER AND WARM/COOLED AIR SERVICES

On refrigeration, domestic cold or chilled water or warm / cooled air services the insulation and its covering / finish shall be continuous, maintained dry, completed and sealed as a vapour barrier throughout before reducing the service to its working temperature. Insulated pipe / duct supports shall be used on the above services to ensure continuity of the insulation and vapour barriers.

The vapour permeance of the finished installation shall not exceed the following when tested using the approved method in BS 5970 and BS 5422:

0.002 g/s.m^2.Pa for refrigeration work

0.010 g/s.m^2.Pa for chilled water installations

0.010 g/s.m^2.Pa for cold water supplies

Protection coatings, adhesives, etc., shall be non-toxic and when dry be Class 0 fire rated. All terminations of and protrusions through the insulation vapour barrier shall be provided with vapour seal mastic (including all valve and vent stems, etc.).

2D-5-1 VALVES AND FLANGES

Insulated valve and flange cover boxes or jackets shall be included for on the following services:

SERVICE	REQUIREMENT
Chilled water / refrigeration services	15mm pipe and above – All valves, pipes and fittings (insulated and vapour sealed)
Cold water services	15mm pipe and above – All valves, pipes and fittings (insulated and vapour sealed)
Steam, LTHW and HWS services	15mm pipe and above – All valves and flanges
Condensate and fuel oil pipework	25mm pipe and above – All Valves and flanges
All external services and services in "cold" roof spaces	15mm pipe and above – valves and flanges

2D-5-1-1 FLANGE / VALVE BOXES

Where installed, each box shall comprise of aluminium (thickness equal to that on pipework) split casing fitted with spring clip fasteners and lined with an insulation material, suitable for the particular service. The boxes (and insulation) shall be suitable for the size and type of valve or flange and shall be neatly and properly finished.

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Boxes shall be installed on all flanges and valves including control valves (but not control motors). All joints in the casings shall be suitably sealed.

Where available, preformed valve and flange insulation mouldings shall be used.

The glands on valve spindles shall project beyond the insulation.

External valve and flange boxes shall be suitably weather proofed and sealed to the pipework to which they are attached. Valve boxes shall include removable covers over hand wheels and stems - refer to BS 5970.

Where required, provision shall be made in the valve and flange boxes to accommodate trace heating of the pipework.

2D-5-1-2 VALVE JACKETS TO VALVES, STRAINERS AND HEAT EXCHANGERS

Where general maintenance or service access is required to plate heat exchangers, strainers, valves or valve sets (including steam trap sets, etc.), fully insulated flexible plate heat exchanger or valve jackets shall be installed.

The valve jackets shall be fixed over valves using Velcro straps with drawstrings at either end of the jacket. The jackets shall have a robust, waterproof fabric finish fully stitched with flexible thermal insulation that meets the overall thermal performance of the insulation applied.

Materials for construction shall be fully suitable for the temperature of the service being insulated, but shall as a minimum meet the following:

ITEM	REQUIREMENT
Inner finish	Silicone coated glass fibre cloth
Outer finish	Woven glass fibre
Insulation	Mineral Wool
Insulation thickness	50mm minimum or as per pipework whichever is greater
Stitching	Polyester cotton
Draw cords	Nylon

Services subject to condensation (including chilled water and cold water services) shall be fully vapour sealed beneath the jackets, with the vapour seal applied directly onto the adjacent pipework and valves (including valve items).

2D-6 WALLS AND FIRE BARRIERS

Where insulated services pass through a structure, the provision must accommodate the insulation unless omitted by detail. At fire barriers, the fire integrity of the barrier must be maintained in accordance with Building Regulations Approved Document B 'Fire Safety'. Fire integrity details shall be proven by test.

At fire barriers and structures, the thickness of insulation may be varied but care must be taken to prevent heat transfer sufficient to cause deterioration of the building fabric.

All services with a vapour barrier shall be arranged such that the vapour barrier is continuous through the wall / fire barrier by use of oversized sleeve or equivalent.

The above requirements shall apply to all insulated ventilation ductwork except for fire barriers where fire dampers are installed, these are detailed elsewhere.

2D-7 EXPANSION BELLOWS

Expansion bellows shall be insulated with preformed rigid sections of the same thickness, density and thermal conductivity as on the adjacent pipework.

The sections shall be applied over the flanges of the bellows and clear of convolutions and bolts. The sections shall be finished (and where installed externally be weather proofed) as for the adjacent pipe and be constructed as for valve boxes. See also BS 5970.

Note: Insulation shall not be applied until any "cold draw" has been taken up.

2D-8 PLANT ACCESS

Aluminium sheet covering or steel sheet with aluminium and zinc coating shall be securely fixed to the insulation in an approved manner and shall be neatly jointed and shaped to suit plant/ equipment contours. Where removable access or sections are incorporated on the plant, the insulation and covering shall be arranged so that it can be removed from the relevant area without disturbing the remainder of the insulated surface. Removable sections of insulation and coverings shall be fitted with approved quick release type fasteners.

Reference shall be made to the requirements / recommendations of BS 5970.

2D-9 FLOOR DUCTS

Pipework installed within floor screeds shall normally be insulated using preferred pipe insulation sections. However, where space does not permit them to be used, pipes shall be insulated by packing plain finished glass or rock fibre mattress insulation beneath, between and above the services, thereby filling the duct with insulation. This approach is only permitted where pipes are hotter than the surrounding space. Where a variety of pipes or just cold water pipes exist all cooling and cold water pipes must be thermally insulated and vapour sealed using pipe insulation i.e. void filled insulation is not permitted.

2D-10 ADHESIVE / SEALANTS

The adhesives/ sealants shall be suitable for the insulation (and condition of use) they are required for.

The adhesives/ sealants used for bonding the insulation, its finishes/ coverings or in providing a vapour barrier shall not in itself, cause a fire hazard or emit dense smoke or toxic fumes in the event of a fire or excessive heat. The application of adhesives / sealants shall comply with the requirements of the Health and Safety at Work Act.

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Adhesives and sealants shall be manufactured by:

1) Temati. Tel No. 01623 636169.
2) Idenden International. Tel No. 01785 272 727.
3) Engineer approved equal manufacture.

2D-11 SLAB INSULATION SUPPORTS

The supports for slab insulation, excluding boiler flue supports, shall be as manufactured by:

1) Bighead Bonding Fasteners Limited. Tel No. 01202 574 601.
2) Idenden International. Tel No. 01785 272 727.
3) Engineer approved equal manufacture.

2D-12 INSULATION OF STORAGE CISTERNS

The preference is for pre-insulated water storage tanks of proprietary manufacture where possible, however, where this cannot be achieved, the following requirements shall apply.

The thermal insulation requirements for cold water storage cisterns, serving hot and cold water installations shall be to the following minimum requirements:

40mm thick phenolic foam slabs with factory applied aluminium foil giving a Class 0 finish on the outer face shall be applied to all sides/ faces of the cistern. The slabs shall be shaped to clear flanges, access covers, etc., and arranged for removal (all slabs) to facilitate inspection of cistern plates/ panels. Where manholes occur, the covers shall be insulated such that they can be easily removed when required. The insulation slabs shall be secured by fasteners or hangers.

Where the insulation supports penetrate the insulation foil, dead soft aluminium foil tape shall be used. Supports may penetrate the outer surface of the slab where the slabs are fixed to the underside of the cistern. Insulation joints, etc. shall be sealed with dead soft aluminium foil tape.

Care shall be taken to ensure that all punctures, joints, etc., are effectively sealed. Tape shall be 100mm wide self-adhesive. The surface to which the tape is applied shall be clean and dry and the tape pressured firmly into place.

On completion of the above, all tanks and storage cisterns shall be additionally finished with 24 gauge aluminium sheeting or steel sheet with aluminium on zinc coating, fitted overall and arranged with quick release fastenings to facilitate easy removal for inspection of the tank.

2D-13 IDENTIFICATION

All insulated pipework and ductwork services shall be identified with colour bands to BS 1710, unless the colour code at an existing facility is different or if alternatives are detailed elsewhere within this specification, in which case the Engineer shall be consulted.

Identification bands shall be a minimum of 100mm wide and shall be applied on the insulation to each service at 6 metre internals and at all branches and on both sides of any floors and walls through which the service(s) pass.

All services shall be further identified with the name of the pipe/ duct contents on the insulation, adjacent to all valves or dampers, at all changes in direction, at all inlets and exits to ducts and departments and at either side of walls, or floors. The size of lettering shall be a minimum of 25mm high.

Arrows indicating the direction of flow of the pipe/ duct contents shall also be applied adjacent to the name of the contents. The arrows shall be a minimum of 75mm long. On heating, hot, chilled water and refrigeration services, etc., add 'FLOW' to denote flow and 'RETURN' to denote return.

The lettering and arrows shall be black or white to contrast with the colour of the insulation. Warning labels shall be fixed to the insulation on electric trace heated pipelines stating the voltage.

After installation (and insulation where specified), ductwork shall be identified by colour coding, in accordance with BESA DW 144 - Specification for Sheet Metal Ductwork.

Un-insulated pipework, etc. where concealed, shall be left unpainted except for steel pipes, which shall be primed or painted, see Standard Technical Clauses for requirements. In exposed areas, pipework/ ductwork will be painted in normal decorative colours, identification shall be provided at appropriate points, within the building/ department, where the services enter and leave.

Note: Aluminium based paints shall not to be used in the vicinity of flammable liquids or flammable gases due to the possible risk of an explosion.

2D-14 GENERAL THICKNESS OF INSULATION

The insulation thicknesses listed in the following tables shall be used for the project as they exceed the minimum recommendations listed in BS5422 in order to meet the minimum best practice Energy Technology List requirements and Non-domestic Compliance Building Services Compliance Guide to not exceed the heat gains and heat losses listed in the tables.

Should the Contractor propose different insulation types or materials they shall ensure that the heat gains and losses for each pipe size are not exceeded as listed in these tables below.

On projects where Value Engineering is proposed, the Contractor shall ensure that any revised thermal insulation allowances meet the minimum requirements detailed in the Non-Domestic Building Services Compliance Guide and NOT simply revert to those thicknesses detailed in BS 5422 as these may in some circumstances, be insufficient to meet all the requirements of Building Regulations. Irrespective of any Value Engineering offered, any reduced thermal insulation performance shall not compromise other legal requirements such as hot and cold water reaching outlets at specific legal temperatures within time limits dictated by other British Standards and other legislations.

The tables on the following pages are derived from current guidance referred to in Building Regulations Part L and British standards but some of the thicknesses have been increased to minimise energy waste and heat transfer between fluids, air and water of different temperature. When using the tables, the Contractor shall note the following:

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- Thickness of insulation are calculated against the criteria stated in the particular table, where actual conditions differ the nearest more onerous condition shall be used.
- The thicknesses shown are the minimum required and do not take account of manufacturers standard thicknesses, the Contractor shall select the nearest equal or larger sized insulation from the manufacturers range.
- These tables establish the minimum requirements; refer to specific sections of this specification for particular requirements, which shall be adopted if more onerous.
- Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing under extreme conditions. In these cases, 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 trace heating.
- Thickness calculations ignore the specific heat capacity and surface resistance of the insulation.

2D-15 DUCTWORK INSULATION THICKNESS REQUIREMENTS

ENVIRONMENTAL THICKNESS OF INSULATION FOR DUCTWORK CARRYING WARM AIR ONLY		
Environmental thickness of insulation - heat loss not to exceed 16.34W/m^2		
	Phenolic Foam	Mineral Wool
	λ = 0.025 W/mK	λ = 0.033 W/mK
Heated spaces including ceiling voids, internal risers and thermally insulated plant rooms(1)	25mm	40mm
Frost protection insulated or un-insulated plant rooms and external ductwork(2)	50mm	80mm

The above thickness values are applicable for the vast majority of building services ductwork installations where the ventilation system supplies tempered air only to occupants.

(1) Above values are based on insulation thickness calculated in accordance with BS EN ISO 12241 using standardised assumptions of horizontal duct with 35ºC dry bulb supply air and vertical sidewall in still air at 15ºC db.

(2) Above values are based on insulation thickness calculated in accordance with BS EN ISO 12241 using 'non-standard practical' assumption of horizontal duct with 35ºC dry bulb supply air and vertical sidewall in still air at -5ºC saturated.

Applications where the supply air is greater than 35ºC db and the surrounding air cooler shall require formal calculations in accordance with BS EN ISO 12241 to prove heat gain is less than 16.34W/m^2 to comply with Non-domestic Building Services Compliance Guide, as thicker insulation may be required.

THICKNESS OF INSULATION ON INTERNAL DUCTWORK CARRYING COOLED OR CONDITIONED AIR		
Thickness of insulation - heat gain not to exceed 6.45W/m^2		
	Phenolic foam	Mineral wool
	λ = 0.025 W/mK	λ = 0.033 W/mK
Ceiling voids, internal risers and thermally insulated plant rooms(3)	40mm	60mm
Frost protection insulated or un-insulated plant rooms and external ductwork(4)	65mm	100mm

The above thickness values are applicable for the vast majority of building services ductwork installations where the ventilation system supplies tempered air only to occupants.

(1) Above values are based on insulation thickness calculated in accordance with BS EN ISO 12241 using standardised assumptions of horizontal duct with 13°C db supply air and vertical sidewall in still air at 25°C db.

(2) Above values are based on insulation thickness calculated in accordance with BS EN ISO 12241 using 'non-standard practical' assumption of horizontal duct with 13°C db supply air and vertical sidewall air at 32°C db.

Applications where the supply air is lower than 13°C db and the surrounding still air warmer shall require formal calculations in accordance with BS EN 12241 to prove heat gain is less than 6.45W/m^2, to comply with Non-domestic Building Services Compliance Guide, as thicker insulation shall be required.

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2D-16 PIPEWORK INSULATION THICKNESS REQUIREMENTS

NON-DOMESTIC HEATING WATER SERVICES THERMAL INSULATION INTERNALLY LOCATED HEATED SPACES - ECA THICKNESSES									
Outside pipe diameter	LTHW (≤95°C)			MTHW (96°C to 120°C) and Condensate			HTHW (121°C to 150°C)		
	Max. heat loss	Thickness of insulation based on air at 15°C		Max. heat loss	Thickness of insulation based on air at 15°C		Max. heat loss	Thickness of insulation based on air at 15°C	
		Phenolic	Mineral Wool		Phenolic	Mineral Wool		Phenolic	Mineral Wool
		λ = 0.026 W/mK	λ = 0.040 W/mK		N/A	λ = 0.045 W/mK		N/A	λ = 0.054 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)
≤17.2	7.78	20	40	10.57	N/A	50	13.27	N/A	70
21.3	8.42	20	40	11.25	N/A	50	14.06	N/A	70
26.9	9.05	25	45	12.06	N/A	65	15.02	N/A	75
33.7	9.86	25	50	13.04	N/A	65	16.07	N/A	80
42.4	10.83	30	55	14.12	N/A	70	17.34	N/A	90
48.3	11.42	30	60	14.8	N/A	75	18.09	N/A	90
60.3	12.61	35	60	16.22	N/A	80	19.62	N/A	100
76.1	14.12	35	65	17.88	N/A	90	21.41	N/A	105
88.9	15.28	35	65	19.2	N/A	90	22.87	N/A	110
114.3	17.51	40	70	21.66	N/A	90	25.53	N/A	115
139.7	19.72	40	70	23.99	N/A	100	27.98	N/A	125
168.3	22.34	45	75	26.63	N/A	100	30.69	N/A	125
219.1	26.61	45	75	31.15	N/A	110	35.25	N/A	135
273	30.91	50	80	35.83	N/A	120	40.05	N/A	140
Vessels & flat surfaces	Refer to particulars section			Refer to particulars section			Refer to particulars section		

NON-DOMESTIC HEATING WATER SERVICES THERMAL INSULATION EXTERNAL AND UNHEATED SPACES									
Outside pipe diameter	LTHW (≤95°C)			MTHW (96°C to 120°C) and Condensate			HTHW (121°C to 150°C)		
	Max. heat loss	Thickness of insulation based on air at -5°C		Max. heat loss	Thickness of insulation based on air at -5°C		Max. heat loss	Thickness of insulation based on air at -5°C	
		Phenolic	Mineral Wool		Phenolic	Mineral Wool		Phenolic	Mineral Wool
		λ = 0.026 W/mK	λ = 0.040 W/mK		N/A	λ = 0.045 W/mK		N/A	λ = 0.054 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)
≤17.2	7.78	30	50	10.57	N/A	65	13.27	N/A	90
21.3	8.42	30	50	11.25	N/A	65	14.06	N/A	90
26.9	9.05	35	60	12.06	N/A	85	15.02	N/A	100
33.7	9.86	35	65	13.04	N/A	85	16.07	N/A	100
42.4	10.83	40	70	14.12	N/A	90	17.34	N/A	120

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NON-DOMESTIC HEATING WATER SERVICES THERMAL INSULATION EXTERNAL AND UNHEATED SPACES									
Outside pipe diameter	LTHW (≤95°C)			MTHW (96°C to 120°C) and Condensate			HTHW (121°C to 150°C)		
	Max. heat loss	Thickness of insulation based on air at -5°C		Max. heat loss	Thickness of insulation based on air at -5°C		Max. heat loss	Thickness of insulation based on air at -5°C	
		Phenolic	Mineral Wool		Phenolic	Mineral Wool		Phenolic	Mineral Wool
		λ = 0.026 W/mK	λ = 0.040 W/mK		N/A	λ = 0.045 W/mK		N/A	λ = 0.054 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)
48.3	11.42	40	75	14.8	N/A	100	18.09	N/A	120
60.3	12.61	45	75	16.22	N/A	100	19.62	N/A	130
76.1	14.12	45	90	17.88	N/A	120	21.41	N/A	140
88.9	15.28	45	90	19.2	N/A	120	22.87	N/A	140
114.3	17.51	50	90	21.66	N/A	120	25.53	N/A	150
139.7	19.72	50	90	23.99	N/A	130	27.98	N/A	160
168.3	22.34	60	90	26.63	N/A	130	30.69	N/A	160
219.1	26.61	60	90	31.15	N/A	140	35.25	N/A	170
273	30.91	65	100	35.83	N/A	150	40.05	N/A	180
Vessels & flat surfaces	Refer to particulars section			Refer to particulars section			Refer to particulars section		
Thicknesses based on ambient of -5°C rather than 15°C, thickness of insulation increased proportionally to ensure stated heat losses are met.									

CATALYST DESIGN SUPPLEMENT BY FAIRHEAT FOR DISTRICT HEATING TO APARTMENTS ONLY NON-DOMESTIC HEATING WATER SERVICES THERMAL INSULATION			
Outside pipe diameter		Thickness of insulation based on air at 15°C	
		Phenolic	Mineral Wool
Steel	Copper	λ = 0.026 W/mK	λ = 0.040 W/mK
		(mm)	(mm)
DN15	15mm	25	-
DN20	22mm	30	-
DN25	28mm	30	-
DN32	35mm	30	-
DN40	42mm	35	75
DN50	54mm	40	75
DN65	67mm	40	80
DN80	76mm	40	80
DN100	108mm	50	95
DN125	133mm	60	110
DN150	159mm	60	110
DN200	-	70	125
DN250	-	70	125

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DOMESTIC / RESIDENTIAL HEATING AND HOT WATER WITHIN DWELLINGS / RESIDENCES (NOTE: OUTSIDE OF THE ACTUAL RESIDENCES / APARTMENTS USE 'NON-DOMESTIC' TABLES!!)			
HEATED, UNHEATED AND EXTERNAL LOCATIONS			
Outside pipe diameter	HWS and LTHW at 60°C based on air at 15°C and high emissivity of finish of 0.95		
	Max. heat gain	Thickness of insulation	
		Mineral Wool	Flexible Foam Rubber
		λ = 0.033 W/mK	λ = 0.045 W/mK
(mm)	(W/m)	(mm)	(mm)
8	7.06	-	13
10	7.23	-	13
12	7.35	-	19
15	7.89	20	19
22	9.12	20	25
28	10.07	20	25
35	11.08	20	25
42	12.19	20	-
54	14.12	20	-

REFRIGERATION PIPEWORK THERMAL INSULATION		
HEATED, UNHEATED AND EXTERNAL LOCATIONS		
		Operating at ≥5°C
Pipe diameter	Nominal pipe size	Thickness of insulation based on air at 28°C
Metric	Imperial	λ = 0.035 W/mK
(mm)	(")	(mm)
12.7	1/2	19
15.9	5/8	19
19.0	3/4	19
22.2	7/8	19
25.4	1	19
28.6	1 1/8	19
31.8	1 1/4	19
34.9	1 3/8	19
38.1	1 1/2	25
41.3	1 5/8	25
Larger sizes		Refer to BS 5422 Annex F
The thermal insulations listed above are for typical IT cooling and for both heat pumps and cooling only comfort systems only. All other refrigeration installations shall be insulated in accordance with BS 5422, in particular Annex F.		

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NON-DOMESTIC HOT AND COLD WATER SERVICES THERMAL INSULATION INTERNALLY LOCATED HEATED SPACES - ECA THICKNESSES (HWS ONLY)						
Outside pipe diameter	HWS Pipes at 60°C (and 43°C blended)			CWS Pipes at >10°C		
	Max. heat loss	Thickness of insulation based on air at 15°C		Max. heat gain (1)	Thickness of insulation **(CWS matches HWS)**	
		Phenolic	Mineral wool		Phenolic	Mineral wool
		λ = 0.026 W/mK	λ = 0.039 W/mK		λ = 0.025 W/mK	λ = 0.033 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)
≤17.2	6.04	15	30	2.48	15	30
21.3	6.45	20	35	2.72	20	35
26.9	7.00	25	35	3.05	25	35
33.7	7.71	25	40	3.41	25	40
42.4	8.46	25	40	3.86	25	40
48.3	9.01	30	45	4.11	30	45
60.3	9.94	30	45	4.78	30	45
76.1	11.25	30	50	5.51	30	50
114.3	14.29	35	60	7.28	35	60
139.7	16.09	40	60	8.52	40	60
168.3	18.24	40	60	9.89	40	60
219.1	22.06	40	60	12.27	40	60
Vessels and flat surfaces	Refer to particulars section			Refer to particulars section		
(1) – Max heat gain values from table 10 in BS 5422 for cooled and chilled water systems at 10°C.						

NON-DOMESTIC HOT AND COLD WATER SERVICES THERMAL INSULATION UNHEATED AND EXTERNAL SPACES						
Outside pipe diameter	HWS Pipes at 60°C (and 43°C blended)			CWS Pipes at >10°C		
	Max. heat loss	Thickness of insulation based on air at -5°C		Max. heat gain	Thickness of insulation **(CWS matches HWS)**	
		Phenolic(2)	Mineral wool(2)		Phenolic(3)	Mineral wool(3)
		λ = 0.026 W/mK	λ = 0.039 W/mK		λ = 0.025 W/mK	λ = 0.033 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)
≤17.2	(1)	20	35	(1)	20	35
21.3	(1)	25	45	(1)	25	45
26.9	(1)	30	45	(1)	18	45
33.7	(1)	30	50	(1)	24	50
42.4	(1)	30	50	(1)	24	50
48.3	(1)	40	55	(1)	40	55
60.3	(1)	40	55	(1)	40	55
76.1	(1)	40	60	(1)	40	60
114.3	(1)	45	70	(1)	45	70
139.7	(1)	50	70	(1)	50	70
168.3	(1)	50	70	(1)	50	70
219.1	(1)	50	70	(1)	50	70
Vessels and flat surfaces	Refer to particulars section			Refer to particulars section		

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NON-DOMESTIC HOT AND COLD WATER SERVICES THERMAL INSULATION INTERNALLY LOCATED HEATED SPACES - ECA THICKNESSES (HWS ONLY)						
Outside pipe diameter	HWS Pipes at 60°C (and 43°C blended)			CWS Pipes at >10°C		
	Max. heat loss	Thickness of insulation based on air at 15°C		Max. heat gain (1)	Thickness of insulation **(CWS matches HWS)**	
		Phenolic	Mineral wool		Phenolic	Mineral wool
		λ = 0.026 W/mK	λ = 0.039 W/mK		λ = 0.025 W/mK	λ = 0.033 W/mK
(mm)	(W/m)	(mm)	(mm)	(W/m)	(mm)	(mm)

(1) - No specific loss or gain listed under NDBSCG or ECA Guidelines for freezing conditions but maximum permitted heat losses not to exceed values in previous table.

(2) - Thicknesses based on 65K difference (60°C – (-5°C)) rather than 45K (60°C – 15°C).

(3) - Thermal insulation thickness to prevent freezing for 12 hours so all external or at risk cold water pipes MUST also be electrically trace heated.

2D-17 COMBINATIONS OF PERMITTED DUCTWORK INSULATION MATERIAL & COVERINGS

KEY

X	**Shall not be used**
✓	**Default Materials**
O	**May only be used when specifically allowed in particular section of specification**

DUCTWORK SERVICE	LOCATION	THERMAL INSULATION			
		Calcium silicate	Mineral fibre	Phenolic foam	Phenolic foam **Healthcare only**
Supply air	All	X	✓	✓	✓
Extract air with heat recovery	All	X	✓	✓	✓
Intake air to AHUs	All	X	✓	✓	✓
Discharge from AHUs	All	X	✓	✓	✓
Duct flanges	All	X	✓	✓	✓
ALL DUCTWORK INSULATION WITH CONTINUOUS VAPOUR BARRIER					

DUCTWORK SERVICE	LOCATION	COVERING				
		Al foil (Class 0)	Al sheet Stucco/ plain	Plastisol coated Al Sheet	PVC sheet	Synthetic sheet
All Insulated Ductwork including Flanges	Plant Rooms	X	✓	X	O	O
	Ducts	✓	✓	X	X	X
	Cavities/Ceiling and Roof	✓	X	X	X	X
	Occupied (Exposed to view)	X	✓	X	O	O
	Outdoor	X	✓	✓	X	O
ALL DUCTWORK INSULATION WITH CONTINUOUS VAPOUR BARRIER						

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2D-18 COMBINATIONS OF PERMITTED PIPEWORK INSULATION MATERIAL & COVERINGS

KEY

X	**Shall not be used**
✓	**Default Materials**
O	**May only be used when specifically allowed in particular section of specification**

PIPEWORK SERVICE	LOCATION	THERMAL INSULATION			
		Calcium silicate	Mineral fibre	Phenolic foam	Phenolic foam **Healthcare only**
LTHW	All	X	✓	✓	✓
HWS	All	X	✓	✓	✓
HWS @ 100ºC cylinders	All	✓	✓	X	✓
HWS @ +60ºC cylinders	Residential	PRE-INSULATED TO BS 5615 RECOMMENDATIONS			
F & E tanks & cisterns	All	✓	✓	✓	✓
Hot wells	Plant Rooms	✓	✓	X	X
Expansion bellows *	Any Area	✓	✓	X	X
COLD WATER	All	X	✓	O	✓
Cold water storage cisterns	All	X	✓	✓	✓
Refrigeration services	All	FEF (Closed-cell – Class 0) only			
* - Fully in accordance with the expansion bellow manufacturer's recommendations.					

PIPEWORK SERVICE	LOCATION	COVERING				
		Al Foil (Class 0)	Al sheet Stucco/ plain	Plastisol coated Al sheet	PVC sheet	Synthetic sheet
All services with a fluid less than 100°C All services with fluid less than 20ºC shall vapour sealed	Plant rooms	X	✓	X	O	O
	Ducts	✓	✓	X	X	X
	Cavities / ceiling and roof voids	✓	✓	X	X	X
	Occupied (exposed to view)	✓	✓	✓	O	O
	Outdoor	X	✓	✓	X	O
HWS @ +60˚C cylinders	Residential	PRE-INSULATED TO BS RECOMMENDATIONS				
All services with a fluid greater than 100°C, hot wells, boiler smoke boxes & flue ducting, grit arrestor, ID fans, heated oil pipelines	Plant rooms	X	✓	X	X	X
	Ducts	✓	✓	X	X	X
	Cavities/ ceiling and roof ids	✓	✓	X	X	X
	Occupied (exposed to view)	✓	✓	✓	X	O
	Outdoor	X	✓	X	X	X
Expansion bellows	Any area	AS PER VALVES FOR THE SAME SERVICE				
Refrigeration Pipework	Externally as detailed in clause 2D-4-3 of this specification. All internal locations to be self					

Section Two (E)

Electrical Workmanship & Materials

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2E-1 GENERAL DESCRIPTION

This section details the general electrical workmanship and materials requirements and shall be read in conjunction with all other sections of this specification. All electrical installation works shall be undertaken in strict accordance with the clauses detailed herein and the latest version of all applicable standards and guidance.

This section also sets default requirements for methods and/or materials where several alternatives exist. These default requirements shall be followed unless there is explicit instruction to the contrary in a subsequent section dealing with the relevant system in more detail. Where such instruction is unclear or only inferred, written clarification via the Contract Administrator shall be obtained prior to submission of tender costs and in the absence of such the more onerous requirements shall be included.

Throughout this specification references are made to the requirements and recommendations detailed within several statutory and non-statutory standards / documents. It shall be noted the information presented herein is in no way intended to replace the detailed information provided within these documents which must be fully adhered to where applicable.

2E-2 DEFINITIONS

Please refer to the definitions, symbols and abbreviations as detailed within Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations and the following: -

ABBREVIATION / MEANING			
ACB	Air circuit breaker	AFDD	Arc fault detection device
BBC	Backbone bonding conductor	BN	Bonding network
BRC	Bonding ring conductor	CBN	Common bonding network
CPC	Circuit protective conductor	DB	Distribution board
DCL	Device for connecting a luminaire	DNO	Distribution network operator
EBB / ERB	Equipotential bonding busbar / Earth reference bar	ELV	Extra-low voltage
EMC	Electromagnetic compatibility	EMI	Electromagnetic interference
EPO	Emergency power off	EVCS	Emergency voice communication system (Disabled refuge system)
FELV	Functional extra-level voltage	FFE	Furniture, fixtures and equipment
HV	High voltage	LSC	Luminaire supporting coupler
ICT	Information communication technology	IK	Impact protection code
IMD	Insulation monitoring device	IP	Ingress protection code
IPS	Medical isolated power supply system	IT	Information technology
LPZ	Lightning protection zone	LV	Low voltage
MCB	Miniature circuit breaker	MCCB	Moulded case circuit breaker
MSDB	Multi service distribution board	MET	Main earthing terminal
PBB	Primary bonding busbar	PE	Protective conductor
PELV	Protective extra-low voltage	PEN	Protective and neutral conductor (combined)
PME	Protective multiple earthing	PV	Photovoltaic
RBB	Rack bonding busbar	RCBO	Residual current circuit-breaker with integral overcurrent protection
RCCB	Residual current circuit-breaker without integral overcurrent protection	RCD	Residual current device (RCCB or RCBO)
RCM	Residual current monitor	SBB	Secondary bonding busbar
SELV	Separated extra-low voltage	SMDB	Sub-Main Distribution Board
SPD	Surge protective device	TBB	Telecommunications bonding backbone
TBC	Telecommunications bonding conductor	UBC	Unit bonding conductor
UPS	Uninterruptible power supply system	VoIP	Voice over internet protocol

It shall be noted the above abbreviation list is not exhaustive and all other definitions, symbols and abbreviations used within this specification shall be defined upon occurrence.

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2E-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below: -

STANDARDS & DOCUMENTS	
BS 7671	IET Wiring Regulations, including On-Site Guide, Guidance Notes 1-8 and all Codes of Practice
All Statutory Regulations (and Associated Memorandum) detailed within Appendix 2 of BS 7671 – IET Wiring Regulations	
All British Standards detailed within Appendix 1 of BS 7671 – IET Wiring Regulations	
All current and relevant British Standards, as referenced throughout this specification	
For healthcare projects all current and relevant Health Technical Memoranda (HTM's) and Health Building Notes (HBN's)	
All current and relevant Energy Networks Association / ESI publications e.g. Technical Specifications (ENATS), Engineering Recommendations (ER) and Engineering Technical Reports (ETR)	
For Education projects, all current and relevant Building Bulletins by the DfES and other government agencies	
All current and relevant CIBSE (Chartered Institution of Building Service Engineers) guides and supporting documentation	
NJUG National Joint Utilities Group – NJUG Guidelines – Volumes 1 to 6	
The Construction Products Regulation	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Any discrepancies between this specification and the relevant standards shall be referred to Engineer via the Contract Administrator for clarification prior to submission of the tender and in the absence of this clarification the Contractor shall include the most onerous requirements.

2E-4 STATUTORY REGULATIONS & BS 7671 IET WIRING REGULATIONS

All electrical workmanship and materials shall be selected, manufactured, installed, inspected and tested in accordance with the latest version of BS 7671 IET Wiring Regulations in addition to any statutory regulations.

2E-5 ELECTRICAL CONTRACTING CERTIFICATION SCHEMES

The Contractor shall undertake all works in accordance with industry best practice and must be registered with an appropriate certification scheme for the electrical installation works being undertaken which provides a six year guarantee on completion of the works to rectify any non-compliance with the Building Regulations and BS 7671 IET Wiring Regulations.

This shall be the NICEIC / ELECSA – Platinum Promise registration scheme, or equivalent.

2E-6 THE CONSTRUCTION PRODUCTS REGULATION (CPR)

The Contractor shall ensure all electrical installation construction products are suitably certified for their intended use, CE marked in strict accordance with the latest requirements of The Construction Products Regulation, accompanied by a declaration of performance (DoP) and covered by a harmonised European product standard (hEN) or European Technical Assessment (ETA).

All fixed wiring power, control and communication cables shall satisfy the requirements of the Construction Products Regulation in respect of their reaction to fire by being provided in strict accordance with their respective European and British Standards.

2E-7 ACCESSIBILITY & MAINTAINABILITY

Access and maintainability of electrical equipment shall be provided in accordance with the standards listed, and as follows: -

1) Adequate space shall be provided for the initial installation and for its potential replacement at a later date.
2) All equipment shall be installed such that it is accessible for operation, inspection, testing, maintenance and repair.
3) To prevent access by ordinary persons (as defined in BS 7671), equipment shall be located behind lockable doors / covers, or shall only be accessible by the use of a tool.
4) Equipment shall be suitably labelled, and adequate signage provided in accordance with BS 7671 and this specification.
5) Operating instructions shall be provided adjacent to all items of equipment where their function is not obvious.
6) Where items of equipment have removable lids, covers etc., it shall be possible to reinstate these to their original state without damaging cabling or equipment.
7) Access and adequate working space shall be provided to all wiring systems and items of equipment to facilitate maintenance or adaptation. This includes every electrical connection and joint, except for:
   a) Joints designed to be buried in the ground.
   b) Compound filled or encapsulated joints.
   c) Connections between a cold tail and the heating system e.g. ceiling / floor heating or trace heating system.
   d) Joints or connections made in equipment by a manufacturer where access is not required.
   e) Equipment complying with BS 5733, suitably marked as a maintenance free accessory and installed in strict accordance with the manufacturer's recommendations.
8) Suitable access arrangements shall be made for all equipment concealed within roof spaces, ceiling / floor voids and other non-accessible locations e.g. openable or removable access hatches / traps etc.
9) All switchgear and distribution equipment shall be located so that it can be operated and maintained safely.

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2E-8 PROTECTION AGAINST ELECTRIC SHOCK

Protective measures shall be provided by the following: -

1) Basic protection – Protection against electric shock under fault-free conditions.
2) Fault protection – Protection against electric shock under single fault conditions.

Suitable provisions shall be made in the installation where danger or damage is expected to arise due to an interruption of supply.

Additional protection (e.g. RCD's and supplementary protective equipotential bonding) shall be provided as detailed.

The following protective measures are permitted:

1) Automatic disconnection of supply e.g. protective earthing, protective equipotential bonding, protective devices etc.
2) Double or reinforced insulation e.g. Class II equipment.
3) Electrical separation e.g. safety isolating transformer used to supply equipment (shaver socket).
4) Extra-low voltage (SELV and PELV) e.g. ELV lighting in a special location.

Automatic disconnection of supply shall be the primary protective measure. The other forms of protective measure (items 2 to 4 above) shall be provided if required e.g. within special locations.

The following protective measures, for application only where the installation is controlled or under supervision of skilled or instructed persons, are not permitted by this specification: -

1) Obstacles.
2) Placing out of reach.
3) Non-conducting locations.
4) Protection by earth-free local equipotential bonding.
5) Electrical separation for the supply to more than one item of current-using equipment.

2E-8-1 AUTOMATIC DISCONNECTION OF SUPPLY

This protective measure shall provide both Basic and Fault protection: -

BASIC PROTECTION

This shall be provided by: -

1) Basic insulation of live parts.
2) Barriers and/or enclosures.

Insulation shall completely cover live parts, be suitable for its environment and shall only be removable by destruction. It shall be capable of withstanding the electrical, mechanical, chemical and thermal stresses that it may be subjected to during service.

The insulation to electrical equipment shall comply with the relevant standard(s) for that item of equipment. Basic insulation of live parts shall not be provided by paint, varnish, lacquer or similar products.

Barriers and/or enclosures shall: -

1) Be provided to prevent contact with live parts
2) Provide at least the degree of protection IPXXB or IP2X
3) Provide at least the degree of protection IPXXD or IP4X to horizontal or top surfaces which are readily assessible.
4) Be suitable for the environment in which they are installed.

The removal of barriers, opening of enclosures etc. shall only be possible by:

1) The use of a key or tool, or
2) After disconnection of the supply to all internal live parts

Any item made accessible that may retain a dangerous electrical charge shall be suitably labelled.

FAULT PROTECTION

This shall be provided by: -

1) Protective earthing.
2) Protective equipotential bonding.
3) Automatic disconnection in case of a fault.

When an earth fault occurs the impedance of the fault path shall be low enough to cause sufficient current to operate the circuit protective device within the required disconnection times given in BS 7671 without reliance on the operation of RCDs.

ADDITIONAL PROTECTION

Additional protection shall be provided when there is an increased risk of electric shock and shall include: -

1) Residual current devices (RCD's, RCCB's and RCBO's).
2) Supplementary protective equipotential bonding.

Additional protection shall: -

1) Not be used as a sole means of protection against electric shock.
2) Be provided by RCDs with operating current IΔn not exceeding 30mA and an operating time not exceeding 40ms at 5 IΔn

This additional protection shall be provided: -

1) For socket-outlets with a rated current not exceeding 32A.

   Note: A lighting distribution unit complying with BS 5733, luminaire track system, installation coupler, LSC or DCL is not regarded as a socket-outlet with regards to this requirement.

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2) For mobile equipment with a current rating not exceeding 32A for use outdoors.
3) Within (household) premises, AC final circuits supplying luminaires.
4) For all LV final circuits: -
   a) Serving a location containing a bath or shower.
   b) Passing though zones 1 and/or 2 of a location containing a bath or shower.
5) For external lighting LV final circuits to bike stores, telephone kiosks, bus shelters, advertising panels and town plans.
6) Where additional protection is required within special locations as required by Part 7 of BS 7671.

Additional protection shall also be provided to special locations as required by Part 7 of BS 7671 using supplementary protective equipotential bonding conductors between simultaneous accessible exposed-conductive-parts and extraneous-conductive parts.

2E-9 PROTECTION AGAINST THERMAL EFFECTS

Arc fault detection devices (AFDD) conforming to BS EN 62606 shall be provided as a means of additional protection against fire caused by arc faults in AC final circuits for the following locations and as shown on the drawings: -

1) Premises with sleeping accommodation.
2) Locations with a risk of fire due to the nature of processed or stored materials, i.e. BE2 locations (e.g. barns, woodworking shops, store of combustible materials).
3) Locations with combustible construction materials, i.e. CA2 locations (e.g. wooden buildings).
4) Fire propagating structures, i.e. CB2 locations.
5) Locations with endangering of irreplaceable goods.

BE2, CA2 and CB2 locations are defined within Appendix 5 Classification of External Influences of BS 7671.

AFDD's shall be installed: -

1) At the origin of the final circuits to be protected, and
2) In AC single-phase circuits not exceeding 230V.

AFDD's shall be co-ordinated with overcurrent / residual current protective devices and installed in strict accordance with manufacturers' literature.

2E-10 PROTECTION AGAINST IMPACT – CONCEALED CABLING

LV final circuit cabling concealed within the building fabric / structure shall have the following protection against impact: -

<table>
<tr><th>CABLE TYPE AND CABLE SUPPORT/ CONTAINMENT</th><th>CABLES UNDER FLOORS OR ABOVE CEILINGS</th><th>CABLES CONCEALED IN A WALL OR PARTITION AT A DEPTH OF LESS THAN 50mm</th><th>CABLES INSTALLED IN A WALL OR PARTITION THAT INCLUDES METALLIC PARTS (SEE NOTE 1)</th></tr>
<tr><td>Single core insulated non-sheathed cables in metallic cable trunking / metallic conduit</td><td colspan="3">Cable trunking and conduit shall be equipotential bonded and satisfy the requirements for a protective conductor.</td></tr>
<tr><td>Flat multicore insulated sheathed cables (T&E) in metallic cable basket / metallic conduit</td><td rowspan="2">Shall be run at least 50mm from the top or bottom as appropriate, of a joist or batten.
or
Where a 50mm depth cannot be achieved they shall be installed within metallic cable trunking (not cable basket) and metallic conduit that is equipotential bonded and satisfies the requirements for a protective conductor.</td><td colspan="2">Conduit shall be equipotential bonded and satisfy the requirements for a protective conductor.</td></tr>
<tr><td>Flat multicore insulated sheathed cables (T&E) clipped / fixed direct to the building fabric / metallic or plastic capping</td><td>Shall be installed within the prescribed zones detailed within BS 7671.
and
Additional protection shall be provided by RCD's (RCCB's or RCBO's).</td><td>Additional protection shall be provided by RCD's (RCCB's or RCBO's).</td></tr>
<tr><td colspan="4">Notes:-
1) As advised by the IET Wiring Regulations Technical Support Group, unbonded metallic conduit, metallic plate (e.g. on the top of joists) or metallic capping (e.g. run within walls) do not provide adequate mechanical protection
2) RCDs shall have an operating current not exceeding 30mA IΔn and an operating time not exceeding 40ms at 5IΔn
3) Other than just metallic fixings such as nails, screws or the like, e.g. metal stud partitions.</td></tr>
</table>

Default cabling / cable support and containment system, shall be included at Tender and used for installation.

May only be used when detailed in a subsequent section of this specification and on the drawings.

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2E-11 IDENTIFICATION, NOTICES & LABELLING

This shall be provided in accordance with site standards, BS 7671, all supporting IET documentation and the respective standards for different systems.

Where there is a discrepancy between existing site standards and the accompanying specification(s) / drawing(s), written confirmation via the Contract Administrator shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

Where locations is to be defined on labelling, diagrams, schedules / charts the room numbers / names used shall be agreed with the client to ensure co-ordination with the final site room referencing system.

2E-11-1 SAFETY SIGNAGE

Safety signage shall be: -

1) Provided as required for the electrical installation.
2) In strict accordance with The Health and Safety (Safety Signs and Signals) Regulations – Guidance on Regulations – HSE L64, BS 5499, BS ISO 3864 and BS EN ISO 7010.
3) Clearly visible and adequately illuminated by both general lighting and emergency lighting as required
4) Provided in strict accordance with their respective standards e.g. BS 5266 for self-illuminated emergency exit signs.
5) Provided in the following geometric shapes, safety colours and contrast colours: -

SIGN / NOTICE / IDENTIFICATION MEANING	GEOMETRIC SHAPE	SAFETY COLOUR	CONTRAST COLOUR	GRAPHICAL SYMBOL COLOUR	INSTRUCTION AND INFORMATION
Prohibition sign	Circle with diagonal bar	Red	White	Black	A sign prohibiting behavior likely to increase or cause danger e.g. no access for unauthorised persons.
Mandatory sign	Circle	Blue	White	White	A sign prescribing specific behavior e.g. eye protection must be worn.
Warning sign	Equilateral triangle with curved corners	Yellow	Black	Black	A sign warning of a hazard e.g. danger: electricity, nominal voltage exceeding 230 V to earth.
Emergency escape or first-aid sign	Rectangle (square or oblong)	Green	White	White	A sign giving information on emergency exits, first aid, or rescue facilities.
Fire / fire-fighting equipment	Rectangle (square or oblong)	Red	White	White	A sign giving information on fire equipment e.g. fire alarm call point etc.

2E-11-2 IDENTIFICATION, NOTICES & LABELLING COLOURS / TEXT SIZE

All labelling used for the identification of electrical services shall be provided in the following colours: -

SIGN / NOTICE / IDENTIFICATION TYPE	BACKGROUND COLOUR	TEXT COLOUR	NOTES
General information	White	Black	Labelling of general switchgear, electrical equipment and wiring accessories
Fire / fire-fighting equipment	Red	White	Labelling of fire / fire-fighting equipment and the circuits that feed them, (including disable refuge panels etc.)
Fire alarm devices	White	Red	Labelling of fire alarm devices

Identification and labelling of electrical equipment shall be carried out using a mixture of Traffolyte or printed adhesive labels (e.g. Brother / DYMO adhesive tape or similar), depending on the application, as specified hereafter. Critchley / Tyco HLX LSZH cable markers or similar shall be used for cables.

Traffolyte labels shall be fixed by either screws or bolts (not adhesive). Labels higher than 25mm shall have fixings in each corner.

All text shall be in capital letters of the following height: -

1) 25mm for warning notices.
2) 12mm for primary identification labels.
3) 6mm for secondary identification labels and all printed adhesive labels.

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2E-11-3 IDENTIFICATION & LABELLING OF ELECTRICAL EQUIPMENT

GENERAL REQUIREMENTS

1) Each item of switchgear, controlgear and electrical equipment shall be provided with labelling that indicates its purpose.
2) Switchgear and controlgear terminals shall be marked in accordance with BS 5472 and BS 6272.
3) Protective devices shall be labelled so that the circuit protected is easily identifiable and in accordance with BS EN 61439.
4) Indicating equipment shall be provided in strict accordance with BS EN 60073 and BS EN 60447, where the remote operation of switchgear is necessary.
5) All switchrooms (including rooms containing battery systems), cupboards and risers shall have suitable warning signs.
6) A laminated 'Electric shock: First aid procedures' (resuscitation) poster shall be provided adjacent to every low voltage switch panel, MCCB panel board and MSDB multi-service distribution board.
7) All labelling shall be fully coordinated and consistent throughout.
8) Traffolyte identification labels shall be provided to every termination or joint box indicating the type of service contained.
9) All spare ways shall be labelled.
10) Additional labelling shall be provided as required by BS 7671 e.g. nominal voltage exceeding 230 V to earth, alternative supplies from different sources or circuits etc.
11) Traffolyte shall be used for all external labelling and for internal (circuit) labelling to switchpanels and feeder pillars.
12) Handwritten notices and identification labels are not acceptable under any circumstances.

Labelling shall be provided as detailed in the headings below, including the following external labelling to all items: -

1) Switchgear / equipment reference number.
2) General description and Manufacturer's details.
3) Origin / source of supply (e.g. FED FROM ...).
4) Date of installation

LOW VOLTAGE SWITCH BOARDS & FEEDER PILLARS

External labelling to indicate the following: -

1) Form and type.
2) IP rating.
3) Earthing arrangements e.g. TN-C, TN-S, TN-C-S (PME), TT, IT.
4) Nominal voltage.
5) Nominal frequency in Hz .
6) Rated fault current.
7) Busbar rated current, I in A.
8) Incoming device; BS (EN) number, type, rated current in A, settings where relevant.
9) Incoming supply cable(s); circuit reference / number, no. of cables, no. of cores, size and type.
10) Incoming protective conductor cable(s), no. of cores, size and type (if separate).
11) Weight in kg.

Traffolyte labelling shall also be provided externally to all outgoing ways of low voltage switch panels and internally to all outgoing ways of low voltage feeder pillars. For each outgoing way the labelling shall clearly indicate the following: -

1) Circuit description, phase(s) present, supplied switchgear / equipment reference number, (or "Spare")
2) Destination location of the outgoing circuit including the building, floor and room number.
3) Protective device type, BS (EN) number, rating in A and settings (including spare ways fitted with protective devices).
4) Outgoing cable(s) type, size, no. of cables, no. of cores.
5) Outgoing protective conductor cable(s) type, circuit reference, no. of cables, no. of cores, size (if separate).
6) Date of installation if different to main panel

MCCB PANEL BOARDS, CONTROL PANELS, MSDB/SMDB/MCB DISTRIBUTION BOARDS & CONSUMER UNITS

External labelling shall generally be as described above for switch boards apart from those that are inapplicable e.g. form and type does not apply to final distribution boards. Traffolyte shall be used.

Printed adhesive labelling fixed to the manufacturer's internal labelling boxes adjacent to each outgoing way / circuit shall be provided to indicate: -

1) Circuit description and/or the supplied equipment reference number
2) Circuit type e.g. DB1, DB2, ring circuit, radial circuit etc.
3) Destination location of the outgoing circuit including the building, floor and room number.

Further technical details shall be provided on the schedules / charts provided internally for each MCCB panel board, MCB distribution and consumer unit (see section below).

ISOLATORS, FUSE SWITCH / SWITCH FUSE DISCONNECTORS & OTHER INDUSTRIAL SWITCHGEAR

External labelling shall generally be as described above for switchpanels apart from those that are inapplicable e.g. form and type does not apply.

CONTACTORS

External labelling to include No. of poles, Coil control voltage in V, Contactor rating in kW / V / I.

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POWER FACTOR CORRECTION UNITS

External labelling to include rating in kVAr and the number of stages.

SURGE PROTECTION DEVICES

External labelling to include the classification e.g. Type 1, kA etc.

ENERGY METERING

Traffolyte labelling shall be provided externally to all metering enclosures and shall clearly indicate the following: -

1) Equipment reference number.
2) General description.
3) Date of installation.

FIRE-FIGHTING / LIFE SAFETY & SECURITY EQUIPMENT

External traffolyte labelling to include: -

1) Any necessary instructions for an emergency situation.
2) Battery autonomy and date when new.
3) For breakers/isolators feeding critical systems, appropriate warning notices e.g. FIRE ALARM – DO NOT SWITCH OFF.
4) On fire fighters' switches, clear "ON" and "OFF" labels in letters not less than 10mm high. (When installed the "OFF" switch position shall be up.).

All emergency voice communication outstations shall be labelled with simple pictogram instructions on how to initiate a call.

Printed adhesive labelling shall be provided for the following: -

1) Fire alarm devices giving loop number, device number and device type.
2) Disabled persons call indicators giving source of call by floor/room number.
3) Fire suppressant release buttons e.g. "EXTINGUISHANT RELEASE".
4) Time delay facilities e.g. "EXTINGUISHANT HOLD-OFF".
5) All security devices giving ID reference.

2E-11-4 LABELLING TO WIRING ACCESSORIES & HIDDEN SERVICES

Labelling shall be provided as follows: -

WIRING ACCESSORIES

1) The face plates of all accessories such as socket outlets, fused connection units, isolators, light switches, etc. shall have printed adhesive labels that indicate the distribution board from which they are fed and their final circuit reference; this shall exclude dwellings.
2) All final circuit references shall be coordinated throughout and consistent on all accessories, schedules and drawings.
3) All fused connection units and isolators shall be labelled as to their purpose. Where available from the specified range, accessories shall have integral engraved labelling e.g. water heater, cooker, etc.
4) Socket outlets identified for cleaners' use shall have the integral engraved labelling 'CLEANER'S SOCKET'.
5) The buttons of scene setting panels shall be labelled showing all scene setting options / programmes to provide ease of use. Where this is not possible, a small laminated clearly legible pictogram shall be permanently fixed adjacent to the devices.
6) Small laminated pictograms shall also be permanently fixed adjacent to all devices where there is insufficient space for printed adhesive labelling e.g. lighting grid switches etc.
7) All data outlets shall have printed adhesive labels that indicate their unique agreed patch panel ID reference, as detailed within Section E5 Voice and Data Systems within this specification (where provided).

Traffoltye labelling shall be used for all externally located accessories and those within dedicated electrical switch rooms, plant rooms and service risers.

HIDDEN SERVICES

Where services are to be concealed above ceilings, colour coded identification markers shall be provided which shall be fixed to the underside of ceilings. These shall be fully co-ordinated with O&M manuals / as-installed information.

The following services shall be identified: -

1) Concealed power supply units.
2) Fire alarm detectors and interfaces.
3) Smoke / fire dampers.
4) Valves / commissioning sets etc.

Fire alarm remote indicators shall be clearly labelled to indicate their function. They shall be sited and/or labelled in such a way as to assist in determining the location of the detectors that they serve.

The appearance and use of colour coded markers must be agreed with the Engineer, Architect and Contract Administrator prior to installation.

2E-11-5 DIAGRAMS & DOCUMENTATION

DIAGRAMS

For each low voltage switch panel and MCCB/SMDB panel board a detailed low voltage distribution schematic(s) shall be provided, mounted within framed clear perspex and screw fixed to an adjacent wall.

The schematic shall be: -

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1) Clearly legible.
2) Minimum size of A2.
3) Minimum text size of 4mm in height when printed.
4) Provided with a drawing legend that includes all the drawing symbols used on the schematic.

The low voltage distribution schematic(s) shall include all upstream switchgear and cabling together with the downstream distribution to the next level. All the panel labelling information as detailed earlier shall be repeated on the schematic.

The low voltage distribution schematics shall be provided in strict accordance with BS 5070 and BS EN 61082.

A drawing(s) shall be provided that details all electrical safety installations for firefighting and life safety services. The drawing(s) shall be located at the origin of the electrical installation and adjacent to any other electrical switchgear (e.g. MCCB panel board, MCB distribution board etc.) to which the firefighting / life safety systems relate.

The drawing(s) shall be mounted within framed clear perspex and screw fixed to an adjacent wall. The electrical safety installations drawing shall detail the exact location of the following: -

1) All electrical equipment and switchgear including switchgear / equipment reference numbers.
2) All firefighting and life safety equipment including final circuit designation and the particulars / purpose of the equipment.
3) Special switching and monitoring equipment for life safety power supplies.

Documentation shall be provided within or adjacent to all MCB distribution boards and consumer units that supply heating cables and embedded heating systems e.g. underfloor or ceiling heating systems, as required by BS 7671. This shall include: -

1) Manufacturer and type of heating units.
2) Number of heating units installed.
3) Length/area of heating units.
4) Rated power.
5) Surface power density.
6) Layout of the heating units in the form of a sketch, drawing, or picture.
7) Position/depth of heating units.
8) Position of junction boxes.
9) Cables, earthed conductive shields and the like.
10) Rated voltage.
11) Rated resistance (cold) of heating units.
12) Rated current of overcurrent protective device.
13) Rated residual operating current of RCD.
14) The insulation resistance of the heating installation and the test voltage used.
15) Product information containing provisions about approved materials in contact with the heating units, with necessary instructions for installation.

In addition to the above, the 'Information for the user of the installation' shall also be provided as detailed within BS 7671.

SCHEDULES / CHARTS

Schedules / charts shall be provided to all low voltage switch panels, MCCB panel boards, MCB distribution boards and consumer units, and shall include the following as a minimum: -

1) Switchgear reference number.
2) General description.
3) Date of installation
4) Circuit information including: -
    a) Circuit reference and phase.
    b) Circuit description and the supplied equipment reference number or final circuit type e.g. DB1. DB2, ring circuit, radial circuit etc. including the destination location of the outgoing circuit by building, floor and room number.
    c) Type of wiring.
    d) Reference method from Appendix 4 of BS 7671 – IET Wiring Regulations.
    e) Number of points served.
    f) Circuit conductor cross sectional area for both live and CPC.
    g) Maximum disconnection time (s) permitted by BS 7671.
    h) Maximum Zs permitted by BS 7671 (MCB not RCBO).
    i) Overcurrent protective devices: -
        i) BS (EN) number.
        ii) Type number.
        iii) Rating (A).
        iv) Short circuit capacity (kA).
    j) RCD operating current IΔn (mA) and type.
    k) Presence of AFDD(s).
5) Method used to provide protection against electric shock e.g. basic protection and fault protection.

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6) Details of all final circuits having a high protective conductor current.

7) Details of any equipment or circuit vulnerable to 500V insulation resistance testing e.g. electronic devices.

It shall be noted the above schedules / charts shall be provided within or adjacent to the associated switchgear.

Where they are mounted adjacent to the item of switchgear they shall be mounted within framed clear perspex and screw fixed to the adjacent wall, however when they are mounted inside distribution boards (e.g. inside the front cover) they shall be laminated and suitably placed / attached.

Schedules / charts shall be provided that detail all current using equipment permanently connected to firefighting / life safety power supplies indicating: -

1) Nominal electric power.

2) Rated nominal voltage, current and starting current.

3) Duration.

The schedules /charts shall be located at the origin of the electrical installation and adjacent to any other electrical switchgear to which the firefighting / life safety systems relate. The schedules / charts shall be mounted within framed clear perspex and screw fixed to an adjacent wall. The schedules / charts shall include the nominal power, rated nominal voltage, current, starting current and duration.

All switchgear reference numbers / codes shall be coordinated throughout and the same on all identification labels, schedules and drawings.

All final circuit references shall be coordinated throughout and the same on all wiring accessories, schedules and drawings.

EXISTING DIAGRAMS, SCHEDULES & CHARTS

Where electrical installation works is undertaken that requires work to existing site LV distribution systems, firefighting / life safety systems and final circuit wiring, the diagrams, schedules and charts shall be updated in strict accordance with the above clauses and shall incorporate all existing installed information.

2E-11-6 IDENTIFICATION OF CABLES

All main and sub-main cabling shall be provided with identification labels / markers so that it can be identified for inspection, testing, maintenance, repair or alteration of the installation.

Printed identification labels / markers (e.g. Critchley / Tyco HLX LSZH cable markers or similar) shall be fixed as follows at: -

1) Each end of the cable.

2) Locations where buried cabling enters / exits the ground.

3) Draw pit locations.

4) Building entry points.

5) Pass between floors.

6) Pass between 60-minute or greater fire compartments.

Each identification label shall include the following: -

1) Cable reference / circuit number.

2) Source and destination location(s).

3) Indication if the cable is run in parallel with other cables.

4) Date of installation in DD/MM/YYYY.

Cable route markers shall be provided to all underground cabling and shall include: -

1) Depth at which the cable is buried.

2) Cable operating voltage.

Cable markers / sleeves as a minimum shall be made from materials equivalent to that of the cabling being labelled e.g. LSZH, LSOH, OHLS etc. They shall also be selected to suit the environment in which they are installed.

Separate protective conductors that are not part of a multicore cable shall have identification labels as detailed above.

2E-11-7 IDENTIFICATION OF CONDUCTORS BY COLOUR & LETTERS / NUMBERS

Cores of cables shall be identified by both: -

1) Colour and,

2) Lettering and/or numbers.

At terminations and throughout the exposed length of every core shall be identifiable and where appropriate binding and sleeves for identification purposes shall comply with BS 3858.

Identification by colour or marking is not required for concentric conductors, bare conductors and the following when used as a protective conductor: -

1) Metal sheath or armour of cables.

2) Extraneous-conductive parts.

3) Exposed conductive parts.

Neutral or midpoint conductors shall be blue.

The colours green-and-yellow shall only be used for protective conductors and the colour combination shall not be less than 30% or more than 70% for each colour. The single colour green shall not be used except for copper strip earthing tape.

Green-and-yellow PEN conductors shall be labelled at the terminations by blue markings and blue PEN conductors shall be labelled at the terminations by green-and-yellow markings.

Lettering and numbering shall be provided to individual conductors or conductors in a group, in accordance with the following: -

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1) Clearly legible and durable.
2) A strong contrast between characters and the insulation of the cable.
3) When used, the numbers 6 and 9 shall be underlined to avoid confusion.
4) Protective conductors shall not be numbered unless for circuit identification.
5) The number 0 shall be reserved for neutral and mid-point conductors.

Conductors shall be identified by colour and alphanumeric / marking as detailed in the table below: -

CONDUCTOR FUNCTION	COLOUR	ALPHANUMERIC / MARKING
Protective conductors	Green-and-yellow	CPC
Functional earthing conductor	Cream	–
AC power circuit[1)]		
Line of single-phase circuit	Brown	L1 / L2 / L3 as appropriate
Neutral of single- or three-phase circuit	Blue	N
Line 1 of three-phase AC circuit	Brown	L1
Line 2 of three-phase AC circuit	Black	L2
Line 3 of three-phase AC circuit	Grey	L3
[1)] Power circuits include lighting circuits.		

At terminations marker sleeves with lettering / numbering shall be provided to each cable core as detailed in the table above e.g. for a three phase circuit, brown shall be L1, black shall be L2, grey shall be L3, blue shall be N.

Protective conductors shall not be lettered / numbered other than for the purpose of circuit identification.

Where terminations are made into switchgear such as switch panels, MCCB panel boards, MCB distribution boards, consumer units, main earth terminals / bars and similar, marker sleeves shall be provided to each cable core.

These marker sleeves shall be in accordance with the alphanumeric marking in the above table and shall also detail the way / circuit reference for which they are terminated into e.g. for final circuits terminated into a three phase distribution board: -

OUTGOING WAY	FINAL CIRCUIT TYPE	CIRCUIT NUMBER / LINE or NEUTRAL or CPC CONDUCTOR	CABLE COLOUR	ALPHANUMERIC / MARKING
Way 1 Line conductors (L1, L2, L3)	Three phase	1/L1	Brown	1/L1
		1/L2	Black	1/L2
		1/L3	Grey	1/L3
Way 1 Neutral conductor	Three phase	1/N	Blue	1/N
Way 1 Circuit protective conductor	Three phase	1/CPC	Green-and-yellow	1/CPC
Way 2 Line conductor (L1)	Single phase	2/L1	Brown	2/L1
Way 2 Neutral conductor (L1)	Single phase	2/N	Blue	2/L1/N
Way 2 Circuit protective conductor (L1)	Single phase	2/CPC	Green-and-yellow	2/L1/CPC
Way 2 Line conductor (L2)	Single phase	2/L2	Brown	2/L2
Way 2 Neutral conductor (L2)	Single phase	2/N	Blue	2/L2/N
Way 2 Circuit protective conductor (L2)	Single phase	2/CPC	Green-and-yellow	2/L2/CPC

Where two or three-core cables (6242* and 6243* flat twin / triple and earth cables) are used for switch wires, intermediate and two-way switch wires, they shall be marked / sleeved as follows: -

FUNCTION	COLOUR	ALPHANUMERIC / MARKING OR SLEEVING
Switch wires – two-core cabling		
Line conductor	Brown[1)]	–
Line conductor	Brown[1)]	–
Intermediate and two-way switch wires – three-core cabling		

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FUNCTION	COLOUR	ALPHANUMERIC / MARKING OR SLEEVING
Line conductor	Brown	–
Line conductor	Black	L or Brown
Line conductor	Grey	L or Brown
[1] 6242* Twin and earth cabling shall have two brown cores when used for switching circuits, blue cores with brown sleeving or the cable marker 'L' may be used as an alternative.		

2E-11-8 IDENTIFICATION OF NEW CABLING (HARMONIZED COLOURS) INTERFACED WITH OLD CABLING (NON-HARMONIZED CABLE COLOURS)

Where there is an addition or alteration to an existing single phase installation and new cabling (to the harmonized colours) is interfaced with old cabling (non-harmonized colours), identification and marking is not required at the interface provided that: -

1) Old cable colours are red for line and black for neutral.

2) New cable colours are brown for line and blue for neutral.

However, where there is an addition or alteration to an existing two or three-phase installation or a DC installation, and new cabling (to the harmonized colours) is interfaced with old cabling (non-harmonized colours), the conductor markings in the table below are required at the interface location: -

CONDUCTOR FUNCTION	NEW CONDUCTOR		OLD CONDUCTOR	
	MARKING	COLOUR	MARKING	COLOUR
Protective conductors	–	Green-and-yellow	–	Green-and-yellow
AC power circuit[1]				
Line 1 of three-phase AC circuit	L1	Brown[2]	L1	Red
Line 2 of three-phase AC circuit	L2	Black[2]	L2	Yellow
Line 3 of three-phase AC circuit	L3	Grey[2]	L3	Blue
Neutral of single- or three-phase circuit	N	Blue	N	Black
[1] Power circuits include lighting circuits. [2] Three single-core cables with insulation of the same colour may be used if identified at the terminations.				

2E-11-9 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

1) A schedule of all identification, notices, labels (including safety signage) and cable identification labels / markers along with a physical sample of each label type.

The time allowed for comment shall be as detailed within section 1B of this specification.

2E-12 EXISTING SUPERVISORY / END-USER MANAGEMENT SOFTWARE

Where electrical installation works is undertaken that requires the integration of electrical systems into existing site supervisory / end-user management software (e.g. fire / voice alarm systems, emergency voice communication systems, disabled persons call systems, emergency lighting systems, security systems etc.) the Contractor shall employ the relevant specialist(s) to: -

1) Update the software so that electrical systems within refurbished, remodelled and new build areas / buildings are fully integrated into the existing software.

2) Incorporate room numbers / names co-ordinated with the architectural drawings and the site room referencing system.

3) Upload and integrate into the existing software the latest floor plans where used as part of an end-user GUI.

2E-13 SELECTION & ERECTION OF WIRING SYSTEMS TO MINIMISE THE SPREAD OF FIRE

To minimise the risk of spread of fire appropriate materials and erection methods shall be selected in strict accordance with The Building Regulations – Approved Document B, BS 9999, BS 7671 and all supporting IET documentation.

2E-13-1 PRECAUTIONS WITHIN A FIRE SEGREGATED COMPARTMENT

The general building structural performance and fire safety shall not be reduced by the installation of wiring systems.

All fixed wiring power, control and communication cables shall meet the flame propagation requirements of: -

1) BS EN 60332-1-2.

2) BS EN 60332-3-24 (where required by cable manufacturing standards – see below).

Note: IET Wiring Regulations requires cables to meet the flame propagation requirements of the BS EN 60332-3 series when installed within 'escape routes' and 'fire-segregated compartments that provide a means of escape in an emergency'. However only XLPE/SWA/LSZH armoured, XLPE/LSZH softskin 'fire rated' and XLPE/SWA/LSZH armoured 'fire rated' cabling is tested to meet these requirements, and this is currently under review by the IET.

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Therefore, cabling need only meet the requirements of BS EN 60332-1-2 where its manufacturing standard does not require testing to the BS EN 60332-3 series.

Where cables do not comply with the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible), they shall be limited to short lengths for connection of appliances to the permanent wiring system e.g. flexible connections. They shall not pass between fire segregated compartments.

Additional measures shall be taken where a 'particular risk of fire' is identified in strict accordance with BS 7671.

2E-13-2 SEALING OF WIRING SYSTEM PENETRATIONS

The sealing of wiring system penetrations shall be as follows: -

1) Where wiring systems pass through floors, walls, roofs, ceilings, partitions, cavity barriers and other elements of the building construction, the penetrations through the building fabric shall be suitably sealed (e.g. fire barriers / stopping) to provide the level of fire resistance and acoustic properties required by the building element that has been penetrated.
2) Manufacturers' proprietary cable transit systems and sleeves shall be utilised which have been tested in strict accordance with BS EN 1366-3. Other systems may be considered if based on sample construction details and written approval by Building Control and appropriate Fire Advisors.
3) Under no circumstances shall expandable foam be used.
4) Cable ducting, cable trunking, conduit and busbar systems etc. shall also be internally sealed to provide the level of fire resistance required by the building element that has been penetrated.
5) Where the wiring system / products are classified as non-flame propagating according to the relevant product standard, internal sealing is not required provided that: -
    a) The wiring system has a maximum internal cross-sectional area of 710mm^2 e.g. 32mm diameter conduit or smaller, or 25 x 25mm trunking.
    b) (However, they may require sealing for other reasons, such as to prevent condensation, in classified hazardous areas etc.).
    c) The system has the degree of protection of IP33 to BS EN 60529.
    d) Any termination of the system in one of the compartments, separated by the building construction being penetrated, has the degree of protection of IP33 to BS EN 60529.
6) Temporary fire stopping arrangements shall be provided if required during the installation works. Existing fire stopping that is disturbed during alteration works shall be reinstated as soon as practical.
7) The fire sealing must also resist external influences to the same degree as the wiring system e.g. resistance to combustion, ingress protection from water, be from compatible material, permit thermal movement and have adequate mechanical stability.
8) Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the fire seal. This is not required if the seal itself is able to provide adequate support under such conditions.
9) Intumescent gaskets and covers shall be provided where electrical equipment or accessories are installed within ceilings or walls whose fire integrity has been compromised by their installation e.g. recessed luminaires in ceilings to maintain the ceilings fire integrity, accessory boxes in thin skinned walls that form part of a fire compartment etc.
10) Gaskets and covers shall be provided where electrical equipment or accessories are installed within ceilings or walls whose acoustic properties have been compromised by their installation e.g. recessed luminaires, accessory boxes in thin skinned walls etc.
11) Labelling shall be provided at each penetration location and shall have a designated unique reference, include the installation date and details of the specialist installer.
12) On completion of the fire barriers / stopping works fully detailed completion / compliance certification shall be provided along with record drawings that detail all fire barrier / stopping locations.

Technical specifications for all manufacturers' proprietary fire stopping systems and materials (e.g. cable transit systems and sleeves) shall be agreed with Building Control / Fire Advisor and the Architect.

2E-14 PROXIMITY OF WIRING SYSTEMS & ELECTROMAGNETIC DISTURBANCES

This section of the specification details the general requirements for the proximity of wiring systems and measures against electromagnetic disturbances.

2E-14-1 PROXIMITY & SEGREGATION OF WIRING SYSTEMS

GENERAL

Electrical services cabling shall be segregated in strict accordance with BS 5266, BS 5839, BS 6701, BS EN 50174, BS EN 62305, NJUG Guidelines, BS 8519, BS 7594, BS 7671 and all supporting IET documentation.

Voltage Band I and Voltage Band II circuits must not be contained in the same wiring system as a circuit of nominal voltage exceeding that of low voltage.

LIGHTNING PROTECTION SYSTEMS

Adequate separation shall be provided between conductors of a lightning protection system and other electrical wiring systems, including extra-low voltage systems. The minimum separation distances shall be calculated by the lightning protection specialist in accordance with BS EN 62305-3.

EMERGENCY LIGHTING SYSTEM WIRING

Emergency lighting system wiring from a central battery system shall be segregated from all other electrical circuits and wiring systems to avoid the risk of mechanical damage, in strict accordance with BS 5266-1.

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FIRE ALARM SYSTEM, VOICE ALARM SYSTEM & EMERGENCY VOICE COMMUNICATION SYSTEM WIRING

Fire alarm system and emergency voice communication system (disabled refuge) wiring shall be segregated from all other electrical circuits and wiring systems in strict accordance with BS 5839-1, BS 5839-8 and BS 5839-9.

Fire alarm system, voice alarm system and emergency voice communication system (disable refuge) wiring may be installed together within the same cable support / containment system, as permitted by BS 5839.

OTHER LIFE SAFETY / FIRE-FIGHTING WIRING

All other life safety / fire-fighting system wiring systems shall be segregated from each other and all other electrical circuits and wiring systems. Primary and secondary power supplies shall be adequately separated from each other so that a failure in a cable or equipment (e.g. mechanical breakdown, damage by fire etc.), in either supply does not affect the other supply.

Where more onerous requirements are detailed within standards, documents or manufacturers' literature relating to life safety / fire-fighting systems, these requirements must be adhered to (e.g. diverse routing of primary and secondary power supplies to fire-fighting lifts, evacuation lifts, smoke ventilation systems etc.).

AUDIO FREQUENCY INDUCTION LOOP SYSTEMS (AFILS)

Loop conductor(s), microphone and other signal cables shall be segregated from all other electrical circuits and wiring systems in strict accordance with BS 7594.

1) Loop cabling shall be installed at least 600mm from low voltage (general power wiring) and extra low voltage systems (fire alarm, security, telecommunications and data wiring etc.). However, the loop cabling shall be installed at least 1000mm from all other audio wiring systems. These requirements shall be verified with the AFILS equipment manufacturers.
2) Line and neutral conductors or switch feeds and switch wires (e.g. conventional two-way switching) must be grouped / run together in areas where AFILS have been installed.
3) Adjacent loops shall be adequately separated from each other dependent upon their classification / type e.g. A1, A2, A3, A4 etc. as required by BS 7594.

INFORMATION TECHNOLOGY & TELECOMMUNICATIONS WIRING

Information technology (e.g. data cabling) and telecommunications wiring systems shall be segregated from all other electrical circuits and wiring systems. This shall include any building services systems that may utilise the information technology / telecommunications wiring e.g. access control, CCTV, BMS etc.

External and internal telecommunication wiring systems by utility service providers e.g. BT, Virgin Media, Hyperoptic etc. shall be segregated from each other in strict accordance with the associated providers guidance e.g. developer guides, design guides etc.

Where underground telecommunications cables and underground power cables cross or are in close proximity a minimum clearance of 100mm shall be maintained unless one of the methods is adopted from BS 7671.

These methods are as follows: -

1) The provision of a fire retardant partition shall be provided between the underground telecommunication and power cables.

   e.g. bricks, clay / concrete cable protection caps, concrete shaped blocks, protective cable conduit or troughs made of fire retardant materials.

   Or,
2) Where underground telecommunication cables and power cables cross, mechanical protection between the cables shall be provided.

   e.g. cable conduit, concrete cable protection caps or concrete shaped blocks.

OTHER WIRING

The following wiring systems shall be fully segregated from each other and all other electrical circuits and wiring systems: -

1) Security systems.
2) BMS.
3) ELV mechanical services controls.

GENERAL INSTALLATION REQUIREMENTS

The general installation requirements are as follows: -

1) Wiring systems that require segregation shall be installed in their own dedicated cable management systems or in common cable management systems that are provided with individual dedicated compartments.

   Where dividers / partitions are installed on-site they must be from the same manufacturer as the cable management system and the manufacturer's proprietary fixings shall be used.

   The compartment walls or dividers / partitions within the common cable management system shall be:-

   a) Securely fixed and manufactured from the same material as the cable management system.
   b) Mechanically strong and continuous throughout the cable management system.
   c) The same height as the sides of the common cable management system and without perforations.
   d) Equipotential bonded to the cable management system.
2) Signalling and data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm.
3) All wiring systems shall have its own cable conduits and shall not be installed in the same conduits as the cables of other wiring systems.
4) Under no circumstances shall any wiring be strapped or fixed to the outside of cable management systems.

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5) Underground electrical wiring systems shall be separated as detailed by the NJUG National Joint Utilities Group or as shown on the drawings. All buried wiring systems shall be installed within their own dedicated cable ducting systems unless specifically shown otherwise.

2E-14-2 PROXIMITY OF WIRING SYSTEMS TO NON-ELECTRICAL SERVICES

Wiring systems shall not be located in close proximity to non-electrical services that produce heat (e.g. hot pipework), smoke or fumes, or below services that may cause condensation (e.g. water, steam, gas services), unless adequate precautions are taken to prevent harmful effects to the wiring.

Mechanical / thermal shielding or suitable spacing shall be provided between electrical and non-electrical services to prevent the operation of one service affecting another.

Under no circumstances shall wet services be installed within LV switch rooms and rooms containing standby battery systems.

Low pressure gas systems shall be separated from electrical equipment in accordance with BS 6891: -

1) Gas pipework shall be at least 150mm from low voltage equipment such as metering, DNO cut-outs / isolators, distribution boards and consumer units.

2) Gas pipework shall be at least 25mm from switches, sockets and low voltage cabling.

The guidance outlined in IGEM/GM/6 shall also be followed: -

1) Gas metering shall not be installed within rooms that are intended for electricity metering and electrical switchgear.

2) Gas metering shall be located away from electricity metering and electrical switchgear and under no circumstances within 150mm.

The only wiring systems that shall be installed within lift or hoist wells shall be those that form part of the lift installation as defined by the BS EN 81 series.

2E-14-3 MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

To avoid and reduce electromagnetic disturbances the electrical installation works shall also be undertaken in strict accordance with the following standards: -

REFERENCE STANDARDS / DOCUMENTS	
BS 6701	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance
BS EN 50310	Telecommunications bonding networks for buildings and other structures
BS EN 50174	Information technology – Cabling installation
BS IEC 61000-5-2	Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling

Where referenced within this section of the specification data and signalling cabling shall include the following non-exhaustive systems: -

1) Information technology and telecommunications systems.
2) All life safety / fire-fighting systems.
3) Security systems.
4) AV/TV/integrated reception systems.
5) BMS systems.
6) ELV mechanical services controls.
7) Nurses call systems.
8) Any other systems that utilise ELV signalling wiring.

Reference shall be made to BS EN 50174-2 for the minimum separation distances from data / signalling cabling to sources of electromagnetic interference (e.g. fluorescent / neon / mercury vapour / high-intensity discharge lamps, arc welders, frequency induction heating, hospital equipment, radio / television transmitters and radars).

As a minimum the following measures must be adopted to avoid and reduce electromagnetic disturbances: -

1) Signalling cabling shall be adequately screened
2) All circuit conductors of low voltage cabling shall be run together in close proximity utilising the same cable support / containment system (e.g. line, neutral and protective earth conductors).
3) Adequate separation and segregation of power (e.g. low voltage) and signalling cables shall be provided.
4) All cable support and containment systems shall be equipotential bonded as detailed within the Earthing and Bonding section within this section of the specification.

Where more onerous measures (e.g. surge protection and/or filters, EMC equipotential bonding networks etc.) are required these shall be detailed elsewhere within this specification.

It shall be assumed, unless unambiguously stated otherwise, that the minimum separation distances given in BS 7671 apply, as summarised below: -

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INSTALLATION METHOD (ALL CABLE SUPPORT & CONTAINMENT SYSTEMS ARE STEEL)		SEPARATION DISTANCE
DATA / SIGNALLING CABLING	LOW VOLTAGE CABLING	
Dedicated cable basket or tray	Free air, cable tray or basket	200mm
Dedicated cable basket or tray	Cable trunking	150mm
Dedicated cable trunking	Cable tray or basket	150mm
Dedicated cable trunking	Dedicated cable trunking	0mm

Notes: -

1) The minimum separation distances shall apply in three dimensions.
2) Signalling and data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm.
3) Where signalling / data cabling and power cabling are required to cross each other and the minimum separation distances cannot be maintained, they must cross each other at 90 degrees for at least the minimum separation distance either side of the crossing.

Electrical safety and measures to avoid / reduce electromagnetic disturbances may produce different segregation or separation requirements; the electrical installation shall meet both requirements.

2E-15 EARTHING & BONDING

This shall be provided in accordance with BS EN 50310, BS EN 50174, BS 7430, BS 7671 and all supporting IET documentation.

The following definitions apply: -

1) Supply system earthing – Where a connection is provided between the source of energy (e.g. generator winding) and the general mass of earth via a source electrode.
2) Electrical installation earthing – Where the exposed-conductive-parts of an installation are connected to an appropriate means of earthing at the origin of the installation e.g. MET.

For intakes at LV, the DNO is normally responsible for supply system earthing and the provision of a connection for the MET.

All earthing and bonding cabling shall be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%.

2E-15-1 EARTHING ARRANGEMENTS

Dependent on the installation earthing arrangements, METs shall be connected to earth by one of the following methods as required by BS 7671:

1) TN-S, to the earthed point of the source of energy, my partly be formed by the DNO's lines and equipment.
2) TN-C-S, where protective multiple earthing is provided, by the DNO to the neutral of the source of energy.
3) TT and IT, via an earthing conductor to an earth electrode.

Earth electrodes shall be provided in accordance with BS 7671 and shall be from the following types: -

1) Earth rods or pipes.
2) Earth tapes or wire.
3) Earth plates.
4) Underground structural metalwork embedded in foundations (e.g. piling) or other metalwork installed in the foundations.
5) Welded metal reinforcement of concrete (except pre-stressed concrete) embedded in the ground.
6) Lead sheaths and other metal coverings of cables (existing installations only).
7) Other suitable underground metalwork.

The following shall not be used as an earth electrode: -

1) Metallic pipework for gases or flammable liquids.
2) Metallic pipework of a water utility supply.

Metal objects immersed into water shall not be used as earth electrodes.

2E-15-2 PROTECTIVE CONDUCTORS

The term protective conductor applies to the following: -

1) Earthing conductors.
2) Protective equipotential bonding conductors.
3) Supplementary protective equipotential bonding conductors.
4) Circuit protective conductors.

The following shall not be used as protective conductors: -

1) Gas pipes.
2) Oil pipes.
3) Flexible or pliable conduits.
4) Support wires or other flexible metallic parts.
5) Constructional parts subject to mechanical stress in normal service.

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Although permissible by BS 7671 the metal enclosures or frames of low voltage switch panels, control gear assemblies and busbar trunking systems shall not be used as protective conductors.

2E-15-3 EARTHING CONDUCTORS

Earthing conductors and connections shall be suitably protected against mechanical damage and corrosion and be suitably labelled.

2E-15-4 MAIN EARTH TERMINALS (MET)

An MET shall be provided to all electrical installations for connection of the following to the main earthing conductor: -

1) Circuit protective conductors.
2) Main protective bonding conductors.
3) Functional earthing conductors (if required).
4) Lightning protection system bonding conductors (if any).
5) Metallic sheath of incoming telecommunications cables (where agreed).
6) Telecommunications bonding conductors from telecommunications PBB (if required).

Main protective equipotential bonding conductors shall be provided from the following extraneous-conductive-parts to the MET: -

1) Water installation pipes.
2) Gas installation pipes.
3) Fuel oil pipes.
4) District heating pipes.
5) Steam pipes.
6) Laboratory and medical gases.
7) Mechanical service installation pipework and ducting (e.g. ventilation, heating, chilled water etc.)
8) Central heating and air conditioning systems.
9) Exposed metallic structural parts of the building.

The above shall be applied to each building where the electrical installation serves more than one building.

Where agreed with the service provider / owner, the metallic sheath of incoming telecommunications cables shall also be equipotential bonded to the MET. Lightning protection systems shall also be connected to the MET.

Disconnection of the main earthing conductor shall be provided to facilitate measurement of the earthing arrangements. This may be provided as part of the main earthing terminal (MET) in the form of a bolted disconnection test link. It shall only be possible to remove disconnection joints / links by means of a tool.

Metallic pipes entering the building having an insulating section at their point of entry need not be connected to the protective equipotential bonding.

2E-15-5 TELECOMMUNICATION PRIMARY BONDING BUSBARS (PBB)

Each building / installation shall be provided with a PBB which shall be connected to the electrical installation main MET as part of a dedicated telecommunications bonding network.

2E-15-6 TELECOMMUNICATION SECONDARY BONDING BUSBARS (SBB)

Each telecommunications, server, equipment, communications room (e.g. main equipment rooms (MER's) and secondary equipment rooms (SER's) shall be provided with an SBB as part of the dedicated telecommunications bonding network.

2E-15-7 PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTORS

Main protective equipotential bonding conductors shall be provided from extraneous-conductive-parts to the MET, as detailed above in the section Main Earthing Terminals.

Generally protective equipotential bonding conductors shall be installed on cable support and containment systems, however where they are fixed to the building structure / fabric they shall be supported at spacing's as detailed within IET Guidance Note 8 – Earthing and Bonding.

SIZING OF MAIN PROTECTIVE BONDING CONDUCTORS – WHERE PME CONDITIONS DO NOT APPLY

Where PME conditions do not apply the minimum cross sectional area of main protective bonding conductors shall be in relation to the size of the line and earthing conductors, as detailed in the table below: -

WHERE PME CONDITIONS DO NOT APPLY		
LINE CONDUCTOR CROSS SECTIONAL AREA	EARTHING CONDUCTOR CROSS SECTIONAL AREA	MAIN PROTECTIVE BONDING CONDUCTOR CROSS SECTIONAL AREA
$4mm^2$ to $10mm^2$	$4mm^2$ to $10mm^2$	$6mm^2$
$16mm^2$ to $35mm^2$	$16mm^2$	$10mm^2$
$50mm^2$	$25mm^2$	$16mm^2$
$70mm^2$ to $400mm^2$	$35mm^2$ to $240mm^2$	$25mm^2$
Note: Assumes all conductors are copper.		

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SIZING OF MAIN PROTECTIVE BONDING CONDUCTORS – WHERE PME CONDITIONS APPLY

Where PME conditions apply the minimum cross-sectional area of main protective bonding conductors shall be in relation to the size of the supply neutral conductor, as detailed in the table below: -

SUPPLY NEUTRAL CONDUCTOR CROSS SECTIONAL AREA	MAIN PROTECTIVE BONDING CONDUCTOR CROSS SECTIONAL AREA
35mm^2 or less	10 mm^2
50mm^2	16 mm^2
70mm^2 to 95mm^2	25 mm^2
120mm^2 to 150mm^2	35 mm^2
Over 150mm^2	50 mm^2

Notes: -

1) Assumes all conductors are copper.
2) DNO conditions may require larger main protective bonding conductors and this should be verified with the DNO.

METALLIC PIPEWORK

The main bonding connections to water, gas or other services shall be made as near as practicable to the point of entry of that service into the building.

Where there is a meter, isolation point or union the connection shall be made: -

1) To the hard metal pipework and before any branch pipework.
2) Where the meter is within the building – Where practicable within 600mm of the meter outlet union when the meter is installed within the building
3) Where the meter is outside of the building – where the service enters the building.

If an insulating section has been provided to prevent galvanic corrosion the bonding connection shall be to the building side only.

Bonding clamps that comply with BS 951 shall be used to make main bonding connections to metal pipework and shall be selected to suit the environment in which they are installed. Where bonding clamps cannot be used due to the size of the pipework other suitable means of connection shall be provided.

STRUCTURAL STEELWORK

The structural steelwork shall be equipotential bonded using proprietary clamps at regular intervals with final connection to the MET by means of a bolted lug type connection.

TELECOMMUNICATIONS PRIMARY BONDING BUSBARS (PBB)

Telecommunications PBB shall: -

1) Be connected to MET using suitably a sized TBC. TBC shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 16mm^2.
2) Provide a central connection point for the building / installation TBB.

SECONDARY BONDING BUSBARS (SBB)

SBBs and RBBs shall be provided as follows: -

1) Each SBB shall be connected to the building / installation telecommunications PBB using a suitably sized TBB / BBC. TBB / BBC shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 16mm^2.
2) Each server, equipment, communications rack or cabinet shall have an integral proprietary RBB (vertical and / or horizontal as required) and shall be equipotential bonded in strict accordance with BS EN 50310 and BS EN 50174.
3) Cabinet, frame or rack mounted equipment (passive or active) shall be equipotential bonded to the horizontal or vertical rack RBB within in each rack using suitably sized UBC. UBC shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 4mm^2.
4) All parts of racks including doors, blank panels, gland plates, and any equipment that is provided with earth studs, shall be equipotential bonded individually to the RBB within each rack.
5) Each RBB shall be connected to the SBB within the same room using suitably sized RBC. RBC shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 4mm^2 for a cabinet, frame or rack of ≤ 21U and 16mm^2 for a cabinet, frame of rack of > 21U.

PHOTOVOLTAIC SYSTEMS

Earthing and bonding (if required) for the DC side of the PV system shall be provided in strict accordance with IEC 62548, BS 7671 and the MCS & ECA – Guide to the Installation of Photovoltaic Systems.

Earthing and bonding to the AC side of the PV system installation shall be provided in strict accordance with BS 7671.

METALLIC CABLE LADDER RACK, CABLE TRAY & CABLE BASKET

All cable ladder rack, cable tray and cable basket / wire mesh systems shall have adequate electrical continuity characteristics as defined in BS EN 61537. A protective bonding conductor shall connect cable ladder rack or cable tray to the main earth terminal (MET) or the equipotential bonding network (for equipotential bonding networks).

The electrical continuity of the cable ladder rack, cable tray and/or basket shall be tested in accordance with BS EN 61537.

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METALLIC CABLE TRUNKING

All cable trunking shall: -

1) Be equipotential bonded using the manufacturer's proprietary components and fixings in strict accordance with the manufacturer's recommendations and with due allowance made for thermal expansion / contraction.

2) Have adequate electrical continuity characteristics as defined in BS EN 50085. A protective bonding conductor shall connect the cable trunking systems to the MET or the equipotential bonding network (for equipotential bonding networks).

The electrical continuity of the cable trunking shall be tested in accordance with BS EN 50085.

METALLIC CONDUIT & FITTINGS

Metallic cable conduit and fittings shall have adequate electrical continuity as defined in BS EN 61386 when connected to cable tray, cable basket and cable trunking. The metallic cable conduit shall be connected to the main earth terminal (MET) via the primary containment systems.

The electrical continuity of the cable conduit shall be tested in accordance with BS EN 61386.

ELECTRICAL EQUIPMENT & WIRING ACCESSORIES

A separate protective conductor shall be run between the earthing terminal within an accessory / equipment and the earthing terminal in the associated back box / enclosure. Notwithstanding Guidance Note 8, a single fixed lug shall not be relied upon as the sole means of continuity.

EMC BONDING NETWORKS

Where EMC equipotential bonding networks are required to avoid / reduce electromagnetic disturbances they shall be detailed elsewhere within this specification.

2E-15-8 SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTORS

Supplementary protective equipotential bonding conductors shall be installed between simultaneous accessible exposed-conductive-parts and extraneous-conductive parts, including where practical, the main metallic reinforcement of constructional reinforced concrete.

The equipotential bonding system shall be connected to the protective conductors of all equipment within the area requiring supplementary protective equipotential bonding (including those of socket outlets).

Supplementary protective equipotential bonding shall be provided where additional protection is necessary within special locations as required by Part 7 of BS 7671.

The cross-sectional area of copper supplementary protective equipotential bonding conductors shall be determined from BS 7671, which can be summarised as follows: -

CABLE TYPE / INSTALLATION	SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTOR CURRENT RATING AND REQUIRED CABLE SIZE		
	TWO EXPOSED-CONDUCTIVE-PARTS	AN EXPOSED-CONDUCTIVE-PART AND AN EXTRANEOUS-CONDUCTIVE-PART	TWO EXTRANEOUS-CONDUCTIVE-PARTS
Sheathed or mechanically protected	Greater than or equal to the cross-sectional area of the circuit protective conductor	Greater than or equal to the cross-sectional area of the circuit protective conductor	Greater than or equal to 2.5mm^2
Non-sheathed single core cabling	Greater than or equal to 4.0mm^2	Greater than or equal to 4.0mm^2	Greater than or equal to 4.0mm^2

Generally metallic ceilings and ceiling grids shall not be supplementary protective equipotential bonded unless detailed elsewhere within this specification.

Where supplementary protective equipotential bonding conductors are fixed to the building structure / fabric they shall be supported at spacing's as detailed within IET Guidance Note 8 – Earthing and Bonding.

2E-15-9 CIRCUIT PROTECTIVE CONDUCTORS

Circuit protective conductors shall only be: -

1) Single core insulated cables (e.g. installed within cable trunking or separate CPC's for armoured cables).

2) Bare conductor within a multi-core cable (e.g. flat twin and earth).

3) Insulated conductor within a multi-core cable (e.g. armoured cable).

4) Metallic sheath, screen or armouring of a cable.

Under no circumstances shall cable support and containment systems be used as circuit protective conductors, however they shall be equipotential bonded, have adequate electrical continuity characteristics in accordance with their respective standards.

Where cable containment systems are required to satisfy the requirements for protection against impact, this shall be independent of other CPCs provided.

Circuit protective conductors provided as per items 1 to 3 above shall be suitably terminated into the electrical switchgear or equipment to which their corresponding final circuit relates.

Where the armouring of a cable is to be used as a circuit protective conductor the armouring shall be suitably connected to electrical switchgear, gland plates or trunking using a brass compression cable gland, gland earth tag washer / ring and gland lock nut. The gland earth tag washer / ring shall be fixed using a suitable stud and shall also be connected with a copper protective conductor and cable lug to the switchgear or equipment earth terminal.

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2E-15-10 HIGH INTEGRITY EARTHING

All sockets outlet final circuits shall be provided with high integrity protective conductor connections: -

1) Ring final circuits shall be provided with ring protective conductors.

2) Radial final circuits shall be provided with dual protective conductors effectively wired in a ring configuration.

All socket outlets (single and twin) shall be provided with dual earth terminals for the separate termination of these.

2E-16 DEFAULT CABLING & CABLE SUPPORT / CONTAINMENT SYSTEMS

The tables below detail the default cabling and support / containment systems that shall be used:-

INTERNAL / EXTERNAL POWER DISTRIBUTION SYSTEMS					
CABLE TYPE & CABLE SUPPORT / CONTAINMENT	HV TRAY	LV TAILS (SEE NOTE 2)	LV TAILS (SEE NOTE 3)	LV MAINS & SUB-MAINS	LV FINAL CIRCUIT
XLPE/SWA multicore armoured cables to BS 6622 / BS 7835 on cable ladder rack	✓	X	X	X	X
XLPE/SWA multicore armoured cables (Aluminium conductors) to BS 6622 / BS 7835 on cable ladder rack	O	X	X	X	X
XLPE/SWA multicore armoured cables to BS 6724 on cable ladder rack	X	O	X	O	X
XLPE/AWA single core armoured cables to BS 6724 on cable ladder rack	X	✓	X	O	X
XLPE/SWA multicore armoured cables to BS 6724 on cable tray	X	O	X	✓	O
XLPE/AWA single core armoured cables to BS 6724 on cable tray	X	O	X	O	X
XLPE split concentric cables to BS 7830-3 on cable tray	X	X	X	O	X
XLPE single core insulated and sheathed cables to BS 7211 on cable tray or in cable trunking	X	X	✓	X	X
6491* single core insulated non-sheathed cables to BS 7211 in metallic cable trunking / metallic conduit / dado with metallic dividers	X	X	X	O	✓
As above however with uPVC conduit replacing metallic conduit	X	X	X	O	O
6242* & 6243* XLPE flat multicore insulated sheathed cables (T&E) to BS 7211/BS 6004 in cable basket / metallic conduit / dado with metallic dividers	X	X	X	X	O
As above however with uPVC conduit replacing metallic conduit	X	X	X	X	O
6242* & 6243* XLPE flat multicore insulated sheathed cables (T&E) to BS 7211/BS 6004 clipped / fixed direct to the building fabric / capping	X	X	X	X	O

Notes:

1) The specification of the Cable Support and Containment Systems is given in a later clause.

2) LV tails that connect a transformer to the main LV panel.

3) LV tails that connect the DNO LV cut-out to the main LV panel.

✓	Default cabling / cable support and containment system, shall be included at Tender and used for installation.
O	May only be used when detailed in a subsequent section of this specification and / or on the drawings.
X	Shall not be used.

BELOW GROUND POWER DISTRIBUTION SYSTEMS					
CABLE TYPE & CABLE SUPPORT / CONTAINMENT	HV 11kV	LV TAILS (NOTE 3)	LV TAILS (NOTE 4)	LV MAINS OR SUB MAINS	LV FINAL CIRCUIT
XLPE/SWA multicore armoured cables to BS 6622 / BS 7835 buried direct below soft dig/paving in uPVC ducts.	✓	X	X	X	X
XLPE/SWA multicore armoured cables (Aluminium conductors) to BS 6622 / BS 7835 buried direct below soft dig / paving in uPVC ducts.	O	X	X	X	X
XLPE/SWA multicore armoured cables to BS 6724 (suitably approved by the manufacturer for being buried direct in the ground or in ducts) for buried direct below soft dig / paving and in uPVC ducts.	X	O	X	✓	✓
XLPE/SWA multicore armoured cables to BS 5467 buried direct below soft dig / paving and in uPVC ducts.	X	O	X	O	O
XLPE/AWA single core armoured cables to BS 6724 buried direct below soft dig / paving and in uPVC ducts.	X	✓	X	O	X
As above but ducted throughout their length.	O	O	X	O	O

Notes:

1) The specification of the Cable Support and Containment Systems is given in a later clause
2) Earthenware ducts are required for contaminated ground conditions
3) LV tails that connect a transformer to the main LV panel.
4) LV tails that connect the DNO LV cut-out to the main LV panel.
5) XLPE/SWA/PVC multicore armoured cables must run within the ground for their entire length and terminate into switchgear / equipment at the point of entry into the building. Under no circumstances shall they be run within buildings.

LIFE SAFETY, FIRE FIGHTING & COMMUNICATION SYSTEMS					
CABLE TYPE AND CABLE SUPPORT / CONTAINMENT	FIRE & SMOKE SYSTEMS	GENERAL ELV	VOICE / DATA	SECURITY SYSTEMS	BMS / CONTROLS
XLPE/LSZH enhanced fire resistant multicore sheathed cables to BS 7629-1 (classification PH120) on cable tray / metallic conduit.	✓	X	X	X	X
LSZH single core cables to BS 7211 in metal trunking/conduit or dado with metal dividers.	X	✓	X	O	O
LSZH multicore cables on cable tray/metal conduit or in cable basket/metal conduit.	X	O	X	✓	✓
LSZH backbone fibre and copper (Cat 6 etc.) data cables in cable basket / metallic conduit / dado with metallic dividers.	X	X	✓	O	O
Mineral insulated (MICC) cables shall be manufactured to BS EN 60702.	O	X	X	X	X

Notes:

1) Voice alarms, central battery emergency lighting and other life safety / fire-fighting shall be as fire alarm & EVCS.
2) Disabled persons call system remote combined overdoor lamp / sounder units, remote control panels or when integrated into an EVCS system shall be as fire alarm & EVCS.
3) BMS cabling operating at LV shall be wired as LV final circuits.
4) When buried underground the above wiring systems shall be ducted throughout their entire length.
5) Standard fire resistant cables with PH30 classification shall not be used for fire-fighting / life safety systems.

✓	Default cabling / cable support and containment system, shall be included at Tender and used for installation.
O	May only be used when detailed in a subsequent section of this specification and / or on the drawings.
X	Shall not be used.

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2E-17 CABLE SUPPORT & CONTAINMENT SYSTEMS

This section of the specification details the general requirements for cable support and containment systems.

2E-17-1 SPARE CAPACITY WITHIN CABLE SUPPORT & CONTAINMENT SYSTEMS

Cable support and containment systems shall be provided with 30% spare capacity and also an additional 30% allowance shall be added to the calculated safe working load (SWL) for supports, for the provision of future cabling.

Where spare capacity is provided to cable ladder rack and cable tray, this shall be a dedicated section of the system and shall not be above or between installed cabling.

2E-17-2 GENERAL REQUIREMENTS FOR CABLE SUPPORT & CONTAINMENT SYSTEMS

All cable support and containment systems shall be provided as follows: -

1) They must be fully continuous throughout and utilise (where applicable) couplers, joint strips, connectors, brackets, bends, gussets, clips, clamps, risers, angles, tees, cross pieces, reducers, bell mouths, end caps, conduit boxes, adaptable boxes, conduit take-off plates and fixing components etc. from the same manufacturer.
2) Where visible, uPVC systems shall be from the same manufacturer so that variations in colour are avoided. uPVC systems shall not be used within environments that have extreme low or high temperatures.
3) Angles, bends, etc. shall be sized to accommodate the minimum bending radius of the largest cabling to be installed, based on the IET On-Site Guide, IET Guidance Note 1 and cabling manufacturer's recommendations.
4) Where possible cabling shall retain its position through all bends, tees, cross pieces etc. so that cross overs are minimised.
5) All fasteners, screws, bolts, washers, nuts, etc. clips shall be the proprietary type from the same material and manufacturer as the system. These shall not create snags that may cause damage to the cabling.
6) Where covers and partitions are specified, they must be from the same material and manufacturer as the system.
7) Covers / lids and dividers / partitions shall be fully continuous throughout the entire system. All covers / lids and dividers / partitions shall be fixed using the manufacturers proprietary screw fixings and self-tapping screws shall not be used.
8) Covers / lids shall be removable. However, where systems pass through the building fabric the covers / lids shall be cut to project 75mm on either side, remaining fixed when the structure is made good.
9) Printed labels shall be fixed at 10m intervals to denote the use of the system. These shall be external to single use systems and attached to partitions on multiple use systems.
10) Where galvanised steel systems, fittings or accessories are cut, all burrs must be removed and edges suitably painted with cold galvanise zinc-rich paint before erection. All cuts shall be straight and squared off. Any damage to the galvanised shall be similarly treated.
11) Where uPVC systems are cut all burrs must be removed and all cuts shall be straight and squared off where required.
12) Proprietary cutters / croppers shall be used in accordance with the manufacturer's recommendations.
13) Adequate allowance shall be made for thermal expansion and contraction. Expansion as opposed to rigid couplers shall also be used across expansion joints of the building structure. Connections that provide electrical continuity shall also allow for thermal expansion / contraction.
14) Calculations for flexible couplers shall be in accordance with the manufacturer's recommendations.
15) Where systems pass through the building(s) suitable measures shall be undertaken to prevent thermal bridging.
16) Non-metallic systems shall not be installed external to the building(s) e.g. uPVC conduit and fittings.
17) Under no circumstances shall slab fixed cable tie support systems be used.

2E-17-3 METAL CHANNEL CABLE SUPPORT SYSTEMS & OTHER ASSOCIATED SUPPORTS

Metal channel (e.g. Unistrut) and/or manufacturer's proprietary systems shall be used to support all cable management systems. The former shall comply with BS 6946. The latter shall be provided in strict accordance with the manufacturer's recommendations.

These systems shall be provided as follows: -

1) All components shall be formed from steel compliant with BS 1449-1 and shall be hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.
2) Supports shall be provided at intervals to prevent excessive deflection of the cable management systems in strict accordance with the manufacturer's recommendations, subject to a minimum interval of 2000mm.
3) Supports shall be provided within 300mm of couplers, brackets, bends, risers, tees, crosspieces, reducers and all other fittings. Vertical cable management systems shall be fixed to metal channel at 1500mm centres.
4) All cut ends of metal channel shall be painted with cold galvanise zinc-rich paint and be fitted with plastic protective caps.
5) Threaded drop rods (minimum 8mm diameter) shall be secured to brackets or supports by vibration proof lock-nuts. All drop rods shall be straight and vertical. Manufacturers' proprietary angle brackets shall be used where necessary. Any projections shall be shortened to within 10mm and fitted with plastic end caps.
6) Supports shall not be shared between services unless designed specifically with this in mind.
7) Under no circumstances shall Gripple wire be used to support primary cable support and containment systems.

2E-17-4 FIRE RESISTANCE OF CABLE SUPPORT & CONTAINMENT SYSTEMS

The fire resistance of cable support and containment systems shall be as follows: -

1) All wiring systems shall be adequately supported to prevent premature collapse under fire conditions in strict accordance with BS 7671. Steel cable support and containment systems are deemed to meet this requirement.

   Under no circumstances shall: -

   a) Non-metallic cable clips or cables ties be used as the sole means of support for cables.
   b) Non-metallic cable trunking be used as the sole means of support of the cables therein.

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c) Non-metallic cable trunking systems pass through walls, floors or fire compartments.

2) All fixing anchors supporting cables or containment systems shall provide equivalent fire resistance. This precludes the use of plastic plugs or similar – all metal fixing anchors shall be used.

3) Containment, supports and clips/cleats/ties shall have the same fire survival time as any fire-fighting / life safety cabling that is being supported, in strict accordance with BS 8519 and BS 5839.

4) For life safety / fire-fighting cabling they shall be fully continuous throughout from source to destination and shall be formed from steel that has been hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.

5) All components shall be sized and selected with consideration for the reduced tensile strength of steel in a fire situation and shall be in accordance with manufacturers' literature.

6) The cross sectional area of drops rods shall be calculated in accordance with BS 8519 and manufacturers' literature.

7) Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the seal, as required by BS 7671. This is not required if the seal itself is able to provide adequate support under such conditions.

8) Internal fire barriers shall be provided where metallic cable trunking systems pass through walls, floors or fire compartments, these fire barriers shall be rated in accordance with the fire compartmentation. Internal fire barriers shall also be installed within vertical cable trunking systems greater than 5m in height.

9) Fully continuous metallic systems that meet the necessary flame propagation requirements (as specified within their respective standards) shall be utilised as opposed to fire-rated clipping, unless agreed with the Engineer via the Contract Administrator.

2E-17-5 CABLE CLEATS & STRAPPING

Cable cleats and strapping shall comply with BS EN 61914 and BS EN 62275, be suitable for the environment in which they are installed, be adequately sized to suit the cable and installed at intervals recommended by the manufacturer. They shall be provided before and after all direction changes.

Where multiple cables share a route they shall run in an orderly manner and retain their positions through direction changes to minimise cross overs.

Cables up to 40mm diameter shall be supported at spacings detailed within the IET On-Site Guide and IET Guidance Note 1. Larger cables shall be supported at spacings as recommended by the manufacturer.

Cable cleats and strapping shall be provided as follows:

CABLING TYPE / SIZE	CABLE CLEAT / STRAPPING TYPE	FIXING METHOD
Single Core Cables	Aluminium alloy or nylon (LSZH) trefoil cable cleats – suitable for clamping three cables together	Two bolt fixings shall be used for vertical cable runs
Multi-Core Cables up to and including 25mm diameter	Perforated / pre-drilled galvanised steel / aluminium cable strapping (all round banding), where coated (LSZH)	Single bolt fixings to both sides of the cables
Multi-Core Cables greater than 25mm diameter	Aluminium alloy or nylon (LSZH) claw type cable cleats	Two bolt fixings shall be used for vertical cable runs

2E-17-6 CABLE LADDER RACK SYSTEMS

Cable ladder rack systems, including all fittings and components, shall: -

1) Comply with BS EN 61537 and be Extra Heavy-Duty type.

2) Be supported on heavy duty trapeze hangers where space allows.

3) Be formed from steel sheet compliant with BS 1449-1 and hot dip galvanised after manufacture to the requirements of BS EN ISO 1461. Deep galvanised, pre-galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.

4) Have a free base area to Classification Z as detailed within BS EN 61537.

Cabling shall be fixed to the rack using straps, saddles or cleats depending upon the diameter of the cabling to be installed.

2E-17-7 CABLE TRAY SYSTEMS

Cable tray systems, including all fittings and components shall: -

1) Comply with BS EN 61537 and by heavy duty, return flange type (medium duty for fire alarm, EVCS or similar.)

2) Be supported from heavy duty trapeze hangers where space allows

3) Be formed from steel sheet compliant with BS 1449-1 and be hot dip galvanised after manufacture to the requirements of BS EN ISO 1461. Deep galvanised, pre-galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.

4) Be perforated to Classification D as detailed within BS EN 61537.

Cabling shall be fixed to the tray using straps, saddles or cleats depending upon the diameter of the cabling to be installed.

5) Conduit take-off plates, shall be utilised to connect conduit to the system.

The cable tray and conduit shall form a fully continuous system throughout from source to destination terminations.

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2E-17-8 CABLE BASKET / WIRE MESH TRAY SYSTEMS

Cable basket / wire mesh tray systems shall comply with BS EN 61537 and shall be supported by metal channel and/or manufacturer's proprietary components e.g. cantilever arms, central hangers, suspension hangers, etc.

Where the term cable basket system is used within this specification it also refers to wire mesh cable tray systems.

Cable basket / wire mesh tray systems, including all fittings and components, shall: -

1) Comply with BS EN 61537
2) Be formed from steel wire welded into a mesh pattern and electro-galvanised after manufacture (electroplated with zinc) to the requirements of BS EN 12329 / BS EN ISO 2081. Deep galvanised, hot dip galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.
3) Include bends, risers, tees, cross pieces etc. that are cut / formed on site using proprietary cutters / croppers in strict accordance with the manufacturer's recommendations.
4) Include conduit take-off plates to connect conduit to the system, the basket and conduit forming a fully continuous wiring channel from cable source to destination terminations.

   Cabling shall be fixed to the basket using cable straps and ties as required.
5) Under no circumstances shall systems be used to support armoured cables or be installed external to the building(s).

2E-17-9 CABLE TRUNKING SYSTEMS

GENERAL REQUIREMENTS

Cable trunking systems shall: -

1) Be supported at spacings as detailed in the IET On-Site Guide, Guidance Note 1 and manufacturers' recommendations.
2) Be sized as detailed within the IET On-Site Guide and IET Guidance Note 1 – Selection & Erection.
3) Utilise proprietary multi-compartment bends, tees and cross overs to maintain full segregation throughout.
4) Include cable retainers at intervals of 600mm where lids are to the bottom or side of the system.
5) Include pin racks on vertical runs at 2m intervals.
6) Provide at least the degree of protection of IP4X or IPXXD to BS EN 60529 and require the use of a tool or deliberate action to secure or remove the trunking lid.
7) Not be installed external to the building(s).

METALLIC CABLE TRUNKING SYSTEMS

This section of the specification does not apply to metallic dado trunking systems.

Metallic cable trunking systems, including all fittings and accessories, shall: -

1) Comply with BS EN 50085
2) Be formed from steel sheet and shall be pre-galvanised before manufacture to the requirements of BS EN 10346. Deep galvanised, hot dip galvanised, stainless steel, powder coated and non-metallic systems shall not be used unless specified elsewhere within this specification.
3) Include circular conduit boxes or couplings, brass male bushes and serrated washers to connect conduit to the system, the trunking and conduit forming a fully continuous containment system from cable source to destination terminations.
4) Not contain conduits passing through compartments to reach the destination compartment
5) Not be used as a circuit protective conductor (CPC) for final circuit wiring, (although shall satisfy the requirements of a CPC where used to provide protection against impact).

uPVC CABLE TRUNKING SYSTEMS

This section of the specification does not apply to non-metallic dado trunking systems.

Non-metallic cable trunking systems, including all fittings and components, shall: -

1) Comply with BS EN 50085 and BS 4678.
2) Be fixed and supported in accordance with manufacturers' recommendation
3) Be heavy gauge white uPVC with the following properties: -
   a) Corrosion resistance.
   b) High impact resistance.
   c) Non-flame propagating.
   d) Self-extinguishing.
4) Not be used unless specified elsewhere within this specification and never in conjunction with metal conduit.
5) Include manufacturer's proprietary couplers, bends, tees, cross overs, end caps etc. and NOT trunking lengths cut on site to form components.
6) Include conduit boxes or couplings / male bushes to connect conduit to the system, the trunking and conduit forming a fully continuous containment system to IP4X or IPXXD from cable source to destination terminations.

2E-17-10 DADO, SKIRTING & BENCH TRUNKING SYSTEMS

GENERAL REQUIREMENTS

1) Where applicable the general requirements for cable trunking systems shall also apply.
2) Systems shall comply with BS EN 50085 and BS 4678.
3) Systems shall be fixed and supported in accordance with manufacturer's recommendations.

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4) Systems shall be suitable for all the types of cabling to be installed, including the category of data cabling (e.g. Cat 6A) and shall not impair the performance of the cabling.

5) Systems shall have a minimum of two compartments and it shall be possible to install manufacturer's proprietary 45mm deep back boxes. (35mm in bench trunking.).

6) Signalling and data cabling shall be installed within a separate compartment to LV wiring and steel screening dividers having a minimum thickness of 1.5mm shall be provided.

7) Dado and skirting trunking shall include cable retainers at intervals of 600mm.

8) Dado and skirting trunking systems shall generally include vertical sections linking to primary containment in the ceiling void. However, where conduit drops are used, these shall be concealed (flush) and connect to the trunking via recessed circular conduit boxes located immediately behind the destination compartment. The number of conduit drops shall be such that 100% spare capacity remains once the specified cables have been installed.

METALLIC DADO, SKIRTING & BENCH TRUNKING SYSTEMS

Metallic dado, skirting and bench trunking systems, including all fittings and components, shall: -

1) Be formed from steel sheet and shall be pre-galvanised before manufacture to the requirements of BS EN 10346 (unless Aluminium systems are specified elsewhere in this specification).

2) Have a white powder coat finish to RAL 9010 or RAL 9003.

3) Include proprietary components selected to suit either dado trunking, skirting or bench trunking systems.

uPVC DADO, SKIRTING & BENCH TRUNKING SYSTEMS

Non-metallic dado, skirting and bench trunking systems shall comply with the requirement given earlier for general uPVC trunking systems and shall include proprietary components selected to suit dado trunking, skirting trunking or bench trunking.

2E-17-11 CONDUIT & FITTINGS

GENERAL REQUIREMENTS

1) Conduit sizes and support spacings shall be as detailed within the IET On-Site Guide and IET Guidance Note 1.

2) Conduit systems shall include spare capacity so that 30% more cable/s of a similar size and type can be installed.

3) Conduits shall be dedicated to a single system/service.

4) The conduit system shall include sufficient accessible draw points to facilitate re-wiring or installation of additional cables in the future. Conduit behind inaccessible ceilings shall be configured as a loop-in system.

5) Conduits less than 20mm diameter shall not be used.

6) Surface conduits shall also be supported within 300mm of floors, ceilings, boxes and at each side of every bend.

7) Fixing of conduits shall be as follows: -
   a) Wall chases or floor screed – Crampets or ordinary saddles.
   b) Ceiling, roof or floor voids – Spacer bar saddles.
   c) Surface mounted on ceiling – Spacer bar saddles.
   d) Surface mounted on walls – Distance saddles.

8) Bends, elbows, tees or u-bends shall not be used. Bends for metallic conduit shall be formed on a proprietary bending machine. uPVC bends shall be formed using a suitably sized spring and by the application of heat.

9) Where conduits are installed for use by third parties, draw wires shall be provided to facilitate the installation of cabling.

10) All conduit boxes and adaptable boxes shall be filled with moisture repelling compound or have drains where there is a risk of condensation and within plantrooms / external locations all box lids shall be fitted with gaskets. In damp environments conduits shall enter wiring accessories from the bottom to prevent the build-up of moisture.

11) Chasing of walls must be carried out in accordance with the Structural Engineer's recommendations. Horizontal chases exceeding 500mm in length or Back to back chasing is not permitted.

12) Conduit shall not be installed within floor screeds or cast-in unless detailed elsewhere within this specification.

METALLIC CONDUIT & FITTINGS

Metallic cable conduit shall comply with BS EN 61386 with resistance to corrosion classification of 'Class 4' and shall: -

1) Comply with BS EN 61386 and have resistance to corrosion classification 'Class 4'.

2) Be formed from heavy gauge steel and hot dip galvanised after manufacture to the requirements of BS EN ISO 1461.

3) Connect to accessory boxes on a concealed installation with couplings, brass male bushes and serrated washers. For surfaces installation, flanged couplers with lead washers shall be used.

4) Be threaded to butt closely together in couplings and sockets.

5) Avoid exposed threads, except at running couplings, where they shall be cleaned, primed and painted with cold galvanise zinc-rich paint after installation.

6) NOT include pressed steel accessories and all conduit boxes, adaptor boxes and accessories shall be formed from malleable cast iron.

7) NOT be used as a circuit protective conductor (CPC) for final circuit wiring, (although shall satisfy the requirements for a CPC where providing protection against impact).

8) NOT include push-fit / quick-fit conduits – all conduit joints shall be threaded.

uPVC CONDUIT & FITTINGS

uPVC conduit and fittings shall be provided as follows: -

1) It shall comply with BS EN 61386 and shall be heavy gauge white or black uPVC and have the following properties: -

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a) Corrosion resistance.
b) High impact resistance.
c) Non-flame propagating.
d) Self-extinguishing.

2) It shall not be used unless specified elsewhere within this specification.
3) Connections to accessory boxes shall be with couplings / male bushes and care must be taken to ensure that all joints are glued correctly.
4) In extremely cold weather the cable conduit shall be slightly warmed before use in accordance with the manufacturer's recommendations.
5) Proprietary steel or brass insert clips shall be fitted where luminaires are suspended from circular boxes to ensure that the weight of the luminaries is carried by the structure rather than the conduit box.

FLEXIBLE & PLIABLE CONDUIT

Flexible and pliable conduit shall comply with BS EN 61386 and be provided as follows: -

1) Metallic flexible conduit shall be formed from helical coiled steel with an overall waterproof sheath.
2) Non-metallic flexible conduit shall be heavy duty, corrosion resistant and non-flame propagating.
3) Non-metallic flexible conduit shall not be used unless specified elsewhere within this specification.
4) Generally it shall be used for the final connection to the following: -
   a) Equipment that is required for ducting, pipework etc. such as control sensors, motorised valves etc.
   b) Equipment subject to vibration e.g. motors, pumps etc.
   c) Equipment where movement may be required for maintenance / access.
5) It shall be connected to conduit boxes and equipment termination boxes using compression glands.
6) The length of flexible conduit shall not exceed 1000mm.
7) Non-metallic flexible conduit shall not be used in environments where heat may be detrimental to its material properties or where additional mechanical protection may be required.

2E-17-12 BELOW GROUND CABLING

DEPTH REQUIREMENTS

Cabling and ducting shall be buried at the following depths unless detailed elsewhere within this specification and/or drawings. These depths are from final finished ground level and care shall be taken to ensure that this is checked prior to installation.

CABLING TYPE / SIZE	MINIMUM DEPTH OF LAYING
High Voltage – 11kV	800mm
Low Voltage	600mm
Communications	450mm
BT Openreach	450mm

All buried cabling and ducting shall also be provided in accordance with NJUG National Joint Utilities Group guidelines.

EXCAVATION

Excavation shall be provided as follows: -

1) All trenches for cables must be straight between points where there are no changes in direction. Trenches must not have step changes in level but be gradual where needed.
2) The bottom of trenches must be smooth and free from stones.
3) Where excavations reveal unsuitable ground containing rocks or ashes with a predominant or unusual chemical content, or any conditions liable to affect the life or performance of the cable, it must be brought to the attention of the Engineer.
4) Means are to be proposed and agreed via the Contract Administrator to minimise the effects on works traffic due to required excavations.
5) Where trench depths exceed 1.2m, trench boarding must be provided.
6) Where other services are encountered, during excavation, adequate support and protection must be provided particularly when digging, backfilling and cable pulling.
7) In conditions which may result in trenches flooding, the provision of pumping equipment must be allowed for. The method of disposing of pumped liquid must be approved.

CABLING IN TRENCHES

Cabling in trenches shall be provided as follows: -

1) Cables must be laid in the trenches using roller, or other approved devices, to prevent dragging, and consequent abrasion.
2) A minimum horizontal space of 300mm must exist between adjacent cables of differing service unless otherwise specified.
3) Cables must be laid on a bed of not less than 100mm of soft sand and covered with a further 150mm of hand compacted soft sand. Sifted soil may be used as an alternative, subject to approval via the Contract Administrator.
4) Earthenware or Stokbord, concrete/polypropylene interlocking cover tiles must be laid on the sand/earth directly above and 75mm from the cables, to provide covering at least 50mm wider than the space occupied by the installed cables. The cable tiles must be covered with 75mm of hand compacted, excavated material free from stones or other sharp objects.

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5) Backfilling must be compacted in layers not deeper than 250mm and the final surface reinstated so that after settlement it must be consistent with the surrounding surface level. Surplus material must be disposed of.

6) The excavation must be inspected 12 weeks after the ground finish has been completed, and any hollows must be filled using approved materials and methods.

7) Plastic cable marking tape shall be laid at a depth of 200mm and 'snaked' to cover the width occupied by the cables. The tape must be yellow with black text "CAUTION ELECTRIC CABLE BELOW" printed along its length.

8) Where cables are laid along routes on which the ground will not immediately be made up to its final level, the routes must be marked by temporary notices indicating the danger present, over the total length of the route involved.

9) All temporary markers must be of a durable weatherproof nature and be approved.

10) The ground finish on completion must be similar to that in the immediate area.

CABLE DUCTS

Cable ducts shall be provided as follows: -

1) They must be of reputable manufacture, made from uPVC unless otherwise specified and of minimum 150mm diameter.

2) Earthenware cable ducts shall be used where there are contaminated ground conditions.

3) The ducts must be laid and bedded in such a way as to prevent damage from rocks etc.

4) Where cables pass under areas of hard standing or through foundations etc, they must be enclosed in pipe ducts or sleeves. Protection of ducts running under roads etc. shall be by concrete haunchings or other approved suitable means.

5) The provision of cable draw pits at points of route deviation, and the transition from open ground to ducts must be agreed via the Contract Administrator. Draw pits shall be suitably sized taking into account the number, type and size of cables to be installed. Deep draw pits must be of a sufficient size to allow access to the lowest ducts.

6) High voltage cables must be run in separate ducts to any low voltage cables.

7) Where new ducts clusters are being installed, 25% of the total ways available must be spare, with a minimum of two, unless single way ducts are specified. All spare ducts must be sealed against ingress of water and or vermin, with proprietary products approved by both the duct and cable manufacturer.

8) Cable ducts shall be laid at a gradient away from building entries.

9) A nylon draw cord must be left in each spare duct for its entire length and in any used ducts with spare capacity.

10) Before cables are drawn into any ducts, new or existing, the ducts must be swabbed to ensure that it is free of debris.

11) Before cables are drawn into ducts the entry points must be protected by temporary bellmouths to ensure that there is no damage to the outer serving of the cable during the pulling operation.

12) Following the drawings in of the cable, the duct must be sealed using materials or devices authorised to provide protection against water, vermin, passage of gases, fire etc. These shall be a proprietary product from a specialist manufacturer such as CSD Sealing Systems Ltd.

2E-17-13 SURFACE / EXPOSED CABLE SUPPORT & CONTAINMENT SYSTEMS

Where surface/exposed primary (e.g. cable ladder, tray and trunking) and secondary (e.g. final conduit runs) containment is acceptable, the location and routing of these systems must be agreed with the Engineer/Contract Administrator prior to installation.

2E-17-14 DESIGN REQUIREMENTS

The Contractor shall assume design responsibility for those aspects of the Electrical installation detailed in Section 1B.

2E-18 CABLING & WIRING SYSTEMS

This section of the specification details the general requirements for cabling and wiring systems.

2E-18-1 DEFINITION OF TERMS

Key definitions applicable to this section of the specification:

ABBREVIATION / MEANING			
AWA	Aluminium wire armour	CSP	Chlorosulphonated polyethylene
CY	Multi-core insulated and sheathed PVC or LSOH cables with internal copper wire braiding	EPR	Ethylene propylene rubber
GSWB	Galvanised steel wire braid	HOFR	Heat oil resistant, flame retardant
LSF	Low smoke and fume	LSOH LSZH OHLS	Low smoke zero halogen – Emissions of hydrogen chloride gas < 0.5%
MI	Mineral insulated	PILC	Paper insulated lead covered cables
PVC	Polyvinyl chloride	SWA	Steel wire armour
SY	Multi-core insulated and sheathed PVC or LSOH cables with external steel wire braiding and outer transparent sheathing	TRS	Tough rubber sheath
XLPE	Cross-linked polyethylene	YY	Multi-core insulated and sheathed PVC or LSOH cables

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2E-18-2 GENERAL REQUIREMENTS

All fixed wiring power, control and communication cables shall: -

1) Meet the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible).
2) Satisfy the requirements of the Construction Products Regulation in respect of their reaction to fire by being provided in strict accordance with their respective European and British.
3) Be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%. (Note: General 'LSF' cabling does not comply).

2E-18-3 MANUFACTURERS' IDENTIFICATION OF CABLES

All cables shall have manufacturers' identification, date of manufacture and a specification reference / standard number printed on the sheath to enable testing, if necessary, and traceability.

2E-18-4 GENERAL LV INSTALLATION CABLES

CABLE TYPE	CABLE SPECIFICATION
Single core armoured cables	694*B XLPE/AWA/LSZH single core armoured cables shall be manufactured to BS 6724.
Multicore armoured cables	694*B XLPE/SWA/LSZH multicore armoured cables shall be manufactured to BS 6724.
Split concentric cables	XLPE/LSZH split concentric cables shall be manufactured to BS 7870-3.
Single core insulated non-sheathed cables	6491B LSZH single core insulated non-sheathed cables shall be manufactured to BS 7211.
Single core insulated sheathed cables	6181B XLPE/LSZH single core insulated sheathed cables shall be manufactured to BS 7211.
Flat insulated sheathed cables – Flat twin and earth cables	6242B & 6243B XLPE/LSZH flat multicore insulated sheathed cables shall be manufactured to BS 7211.
Mineral insulated (MICC) cables	Mineral insulated (MICC) cables shall be manufactured to BS EN 60702.
Flexible plastic cables and cords	LSZH/LSZH flexible plastic cables shall be manufactured to BS EN 50525.
Flexible rubber cables and cords	EPR/HOFR flexible rubber cables and cords shall be manufactured to BS EN 50525. EPR or VIR/TRS flexible rubber cables and cords shall be manufactured to BS EN 50525.
* Denotes the number of cores in a multicore armoured cable and can be 2, 3, 4 or 5 cores.	

2E-18-5 INSTALLATION & USE OF 'NON-STANDARD' CABLES OR CABLES TO BS 8436

Cables for low voltage installation shall be selected from table above. Under no circumstances shall the following cables be used.

1) SY cables – LSZH/GSWB/LSZH or PVC/GSWB/PVC – Steel braided, translucent sheath, insulated flexible conductors.
2) YY cables – LSZH/LSZH or PVC/PVC – Usually grey sheath, insulated flexible conductors.
3) CY cables – LSZH/LSZH or PVC/PVC – Tinned copper wire braid, usually grey sheath, insulated flexible conductors.

Where, S = steel braid, Y = LSZH or PVC, C = copper braid.

SY, CY and YY cables that comply with relevant parts of BS EN 50525 and have LSZH sheaths may be used for ELV controls wiring. However, they must not pass from one fire segregated compartment to another unless they comply with the flame propagation requirements of BS EN 60332-1-2 and the BS EN 60332-3 series (where possible).

2E-18-6 FIRE RESISTANT CABLES FOR LIFE SAFETY & FIRE-FIGHTING APPLICATIONS

Cabling to life safety and fire-fighting equipment shall comply with BS 8519 and all supporting standards / documents, the relevant code of practice(s) appropriate to the application and shall be installed in such a manner that circuit integrity will not be impaired during a fire.

Where primary and secondary power supplies are required they shall: -

1) Both have the same fire survival times
2) Each run back to their respective sources using appropriately fire rated cables at every intermediate level of distribution.
3) Be suitably separated from each other and have diverse cabling routes.

Cable support and containment systems shall have the same fire survival time as the cabling that is being supported.

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All life safety and fire-fighting cabling shall be: -

CABLE TYPE	CABLE SPECIFICATION
Soft skin cables	XLPE/LSZH enhanced fire resistant cables manufactured to BS 7629-1. Classification PH120 when tested in accordance with BS EN 50200. Resistance to integrated water spray and mechanical shock test to BS 8434-2 (60 mins – fire and mechanical impact, followed by 60 mins – fire, mechanical impact and water). e.g. Draka FT120, Prysmian FP Plus or similar.
Multicore armoured cables	XLPE/SWA/LSZH enhanced fire resistant armoured power cables manufactured to BS 7846. Classified Category F120 – Resistance to fire with direct mechanical impact and water jet assessed in combination, when tested in accordance with BS 8491 for 120 mins. e.g. Draka FTP120, Prysmian FP600S or similar.
Notes: 1) All life safety / fire-fighting network cabling (e.g. fire alarm, EVCS etc.) shall be soft skin cabling as above. 2) Standard fire resistant cables with PH30 classification shall not be used.	

The above cables shall be used for power and control cabling associated with all life safety and fire-fighting applications, including:

1) Fire and smoke alarm systems,
2) Emergency evacuation systems, (including central battery emergency lighting),
3) Emergency communications systems (including disable refuge alarms).
4) Smoke extract or clearance systems (including associated ventilation opening e.g. sliding doors).
5) Smoke control systems (including pressurisation systems and zone controlled smoke dampers).
6) Automatic fire suppression systems (e.g. water spray, water mist, gas, powder etc.).
7) Non-automatic fire suppression systems (pumped wet riser).
8) Domestic sprinkler system (including booster sets serving both sprinklers and potable water.
9) Automatic fire or smoke barriers (unless these fail safe).

2E-18-7 FIRE PERFORMANCE OF TELECOMMUNICATIONS (VOICE / DATA) CABLING

Telecommunication cables shall satisfy CPR in terms of reaction to fire by being provided in accordance with BS 6701: -

1) All internal cabling shall meet the requirements of: -
   a) EuroClass C_{ca} –s1b, d2, a2 in accordance with BS EN 13501-6.
   b) BS EN 60332-1-2.
   c) BS EN 60332-3-24 (where possible).

   (This shall include cabling run externally where it enters and runs through buildings to equipment locations but does not apply to cabling run externally which terminates into equipment at the point of entry into a building).
2) All other telecommunications cabling shall meet the requirements of:
   a) EuroClass E_{ca} in accordance with BS EN 13501-6; or
   b) BS EN 60332-1-2.

2E-18-8 CABLE GLANDS

Cable glands shall be manufactured to BS 6121 and BS EN 62444, and shall be provided as detailed below: -

TECHNICAL DETAILS	CABLE TYPE		
	STEEL WIRE ARMOUR (SWA) CABLES	ALUMINIUM WIRE ARMOUR (AWA) CABLES	WIRE BRAID ARMOUR (SSWB) CY & SY CABLES
Gland type	CW Brass Gland	CW Aluminium Gland	RXT Brass Gland
Ingress protection	IP66 to BS EN 60529	IP66 to BS EN 60529	IP66 to BS EN 60529
Temperature	-20°C to 90°C	-20°C to 90°C	-20°C to 90°C
Gland material	Brass to BS 2874	Aluminium	Brass to BS 2874
Seal material	LSZH silicone	LSZH silicone	LSZH silicone
Shroud material	LSZH silicone	LSZH silicone	LSZH silicone
Shroud colour	Black	Black	Black
Notes: 1) To achieve the IP66 rating a sealing washer must be provided between the gland and the housing. 2) An earth tag washer / ring must be provided.			

Glands for single core AWA cables shall be installed into non-ferromagnetic metal gland plates (e.g. aluminium / brass).

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Cable glands for life safety / fire-fighting cabling shall have the same fire survival time as the life safety / fire-fighting cabling being installed. The cable gland shroud shall be the same colour as the life safety / fire-fighting cabling to be installed.

Cable glands for hazardous areas (ATEX and explosive atmospheres) shall be suitably certified for use in that environment.

In other instances, cable glands may be manufactured from durable nylon, however they must provide adequate mechanical protection and be suitably IP rated to suit the environment in which they are installed.

All non-metallic parts to cable glands shall be low smoke zero halogen (LSZH) and shall not be low smoke and fume (LSF).

2E-18-9 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for all cabling and wiring systems to be installed.

The time allowed for comment shall be as detailed within section 1B of this specification.

2E-19 INSTALLATION OF FLAT INSULATED SHEATHED CABLES (FLAT TWIN & EARTH)

This section of the specification details the installation requirements for 6242B and 6243B XLPE/LSZH flat insulated sheathed cables (twin / triple and earth) manufactured to BS 7211 and for 6242Y and 6243Y XLPE/PVC to BS 6004. These clauses only apply if twin and earth is the specified wiring system.

GENERAL REQUIREMENTS

1) Twin and earth cabling shall be installed within cable basket and conduit throughout its length.
2) If specifically allowed elsewhere within this specification it may be clipped direct.
3) Regardless of the above installation methods:
   a) Cables that are concealed within walls or partitions at a depth of less than 50mm shall be installed within the prescribed zones detailed within BS 7671 and additional protection shall be provided by RCD's
   b) Cables installed in a wall or partition with an internal construction which includes metallic parts other than just metallic fixings (e.g. metal stud partitions) shall have additional protection provided by RCD's
4) Requirements to provide adequate supports to prevent premature collapse under fire conditions as detailed earlier in this section apply equally to twin and earth cabling.
5) The exposed circuit protective conductor core shall be provided with green and yellow sleeving to the point of termination which shall be secured in place by means of insulation tape or heat shrink.
6) 6242* twin and earth cabling to switches shall have two brown cores (live and switched live)
7) 6243* triple and earth cabling used for two way and intermediate switches shall have brown, black and grey cores with brown sleeving on the black and grey cores
8) Under no circumstances shall twin and earth cabling be laid on suspended ceilings.

CABLE BASKET & CONDUIT INSTALLATION

The basket and conduit installation given earlier in this section fully applies when it is used for twin and earth cabling.

CLIPPED / FIXED DIRECT INSTALLATION

When twin and earth cabling is clipped / fixed directly to the building fabric the following shall apply: -

1) It shall be recessed within the building fabric and shall be adequately supported along its entire length.
2) Proprietary LSZH cable clips shall be used.
3) Clips shall be provided at no less than 250mm spacing's when horizontal and 400mm spacing's when vertical. Cable clips shall also be provided where the cable bends.
4) Under no circumstances shall joists be notched or sawn. Where there are concerns over structural integrity this shall be brought to the attention of the Engineer and Contract Administrator.
5) Where a minimum installation depth of 50mm cannot be achieved in joists / battens in ceilings and floors, twin and earth cables must be installed within metallic conduit and must be equipotential bonded.
6) All holes in boxes and accessories shall have suitably sized rubber grommets.
7) The outer sheath of twin and earth cabling must project at least 10mm into boxes and accessories.
8) Cables shall run in continuous lengths between wiring points i.e. without joints or junction boxes.
9) When installed within partition walls cables shall be drawn through suitably sized holes in noggins / vertical studs at the centre line of the partition construction.

2E-20 WIRING ACCESSORIES

Wiring accessories shall comply with BS 8300, The Building Regulations – Approved Document M and BS 7671. They shall be IP rated to suit their environment (or maintain IP rating of equipment) and installed in accordance with manufacturers' recommendations.

All flush accessories shall be from a common manufacturer and range to achieve a neat and homogenous appearance. This includes audio visual and voice/data system outlets.

Under no circumstances shall screw less, clip-on accessories be used.

A difference of 30 points in Light Reflectance Value (LRV) shall be provided between wiring accessories and their surroundings.

Unless otherwise specified in the system specific sections, wiring accessories shall be dark grey with white rockers on light coloured surrounds.

The appearance and colour shall be agreed in writing with the Engineer, Architect and Contract Administrator prior to installation.

2E-20-1 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

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1) A schedule (including images) and technical specifications for all wiring accessories, along with a physical sample of each wiring accessory type.

2) A physical sample of coloured surrounds / side wings (where called upon elsewhere within this specification).

The time allowed for comment by the Engineer shall be as detailed within section 1B of this specification.

2E-21 POSITIONING & MOUNTING HEIGHTS OF ELECTRICAL SERVICES

Electrical services shall be positioned in accordance with relevant British Standards and in particular BS 8300, and The Building Regulations – Approved Documents M & P.

Compliance with these standards allows a range of mounting heights as shown in the table below, with the preferred height shown underlined. These shall be used as the default heights unless indicated otherwise in system specific sections of this document and the associated drawings, or on architect's room elevation drawings.

All outlet locations shall be marked up on site and agreed with the Engineer/Architect prior to installation.

EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL TO THE CENTRE	NOTES
Metering:		
Metering	1200 –1400mm	Readings shall be visible to a person standing or sitting. Prepay meters shall be protected to prevent child tamper.
Lighting:		
Lighting switches and controls	1000 – 1200mm	Horizontally aligned with door handles (TBC).
Lighting switches for public use	900 – 1100mm	Horizontally aligned with door handles (TBC).
Lighting pull cords	1000 – 1200mm	Bottom of the pull cord to be located within this range.
Outlets:		
13A socket or data/voice outlets	450 – 1000mm	Or 150mm above desks/worktops (1050mm max)
Shaver socket outlets	800 – 1000mm	Generally, to one side of a mirror.
Bathrooms for wheelchair uses:		
Switches, sockets, stopcocks and controls	700 – 1000mm	Outlets switches and controls shall be a minimum of 300mm from the corners of the room.
General:		
Isolators, switches and controls	1200mm	Dependent on equipment being supplied.
Domestic consumer units	1350 – 1450mm	To centre of isolator/lowest row of protective devices
Cooker control units	750 – 1200mm	At least 100mm from the edge of the cooker hob.
Clocks	2500mm	Or 150mm from the top of the clock to the ceiling
Fire alarm:		
Fire alarm control panels	1200mm	At main entrance agreed central control point.
Manual call points	1200mm	
Visual alarm devices	Not less than 2100mm	Dependent on manufacturer to achieve compliance.
Optical beam detectors	Not less than 2700mm	
Door entry and access control:		
Proximity reader (card / fob) / release push button / activation pad	900 – 1100mm	Preferably adjacent to the door handle and within 200mm of the door frame.
Swipe insertion-type reader	900 – 1000mm	As above.
Green emergency break glass	1000 – 1200mm	To align with other door access devices.
Emergency assistance alarm systems:		
Emergency assistance pull cord	800 – 1000mm & 100mm	Two red bangles, one at each of the heights given.
Emergency assistance reset button	800 – 1000mm	
Emergency voice communication systems (EVCS) – Disabled refuge systems:		
Master station / control panels	1200mm	Generally adjacent to the fire alarm panel

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EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL TO THE CENTRE	NOTES
Outstations	1200mm	
Fire-fighting:		
Fire-fighters switches	1200mm when internal 2750mm when external	Adjacent to fire alarm panel (where internal)
Intruder alarm:		
Intruder alarm control panels and keypads	1200mm	
Electric vehicle charging systems:		
Socket outlets	750 – 1200mm	
Equipment with visual displays, however no controls, switches or pushbuttons:		
Equipment with visual displays	1200 – 1400mm	
Emergency lighting:		
Emergency lighting luminaires	Not less than 2000mm	
Mechanical services controls:		
Heating and ventilation controls	750 – 1000mm	See also Controls section of this specification.
Notes: 1) Outlets and controls shall be a minimum of 350mm from the corners of a room or area, unless otherwise stated. 2) Electrical equipment / accessories of the same type shall be mounted at the same height throughout the building. 3) The mounting heights for fire alarm and EVCS control panels may be increased based on agreement of the personnel responsible for their management if ratified by the local fire authority / building control.		

2E-22 ENGINEERS & ARCHITECTS DRAWINGS

All visible elements of the electrical installation shall be set out as detailed on agreed Architect's/Specialist's elevation drawings. In the absence of these the Contractor shall produce elevation drawings for approval.

Any discrepancies between the elevation drawings and this specification (e.g. mounting heights) this shall be brought to the attention of the Contract Administrator for further guidance/instruction.

The symbols used on the Engineer's drawings are not to scale so allowance shall be made for locating any item within a 1000mm radius of the indicated position at no further cost.

The above submissions and liaison shall take place in a timely manner to suit the construction programme.

2E-23 FIXINGS TO THE BUILDING STRUCTURE / FABRIC

These shall comply with BS 5080, BS 8000, BS 8539, BS 7671 and all supporting IET documentation.

Fixings shall not compromise the structural, acoustic or fire performance of the building. The following fixing methods are likely to be acceptable: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Clamp-on bracketry e.g. flange clamps
Heavy loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic expansion anchors / bolts
Light loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic expansion anchors/bolts, plugs/screws
Plasterboard	Wooden patresses, noggins and battens with wood screws Proprietary fixings such as expansion plugs / screws, self-drive fixings, plastic toggles, spring toggles, etc.
Wood	Screws

The following fixing methods are not acceptable: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Cutting and drilling of the buildings structural steelwork
Building structural steelwork	Welding to the buildings structural steelwork
Blockwork and brickwork	Fixings to blockwork and brickwork in the mortar joint.

All fixing anchors supporting cables shall provide fire resistance so as to prevent their premature collapse during a fire as detailed earlier.

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2E-24 ROOM DATA SHEETS (WHERE PROVIDED)

Power supplies, electrical equipment, wiring accessories etc. shall be provided as detailed on the room data sheets.

Any discrepancies between the rooms data sheets and the Architect's / Engineer's drawings / specifications shall be brought to the attention of the Contract Administrator and written confirmation obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

2E-25 ELECTRICAL EQUIPMENT AND SPECIALISTS SCHEDULES

The appendices to subsequent sections of this specification include Electrical Equipment & Specialists Schedules which detail specialists, manufacturers, product ranges and materials (where applicable) that shall be included in the tender submission.

Where possible a number of suppliers have been provided for items of equipment to give a reasonable choice to the Contractor.

Where more than one specialist, manufacturer, product range or material is specified, this may be due to: -

1) Alternatives not being available which are equivalent.
2) To match existing site installations or site standards.
3) Specification by the Employer.

Reference shall be made to Section 1B with regards to the proposal of alternative equipment.

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Section Two (F)

Electrical Inspection and Testing

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2F-1 GENERAL DESCRIPTION

This section details the inspection and testing requirements for new installation work (including alterations and additions to existing installations) and the replacement of electrical switchgear).

These requirements shall be followed unless there are explicit instructions to the contrary in a subsequent section of this specification (e.g. site specific witnessing requirements). Where such instructions are unclear or only inferred, written confirmation from the Engineer shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

Throughout this section references are made to requirements and recommendations detailed within several statutory and non-statutory standards / documents. It shall be noted the information presented herein is in no way intended to replace the detailed information provided within these documents which must be fully adhered to where applicable.

This section does not cover the testing of specialist systems e.g. lighting controls, fire-fighting and life safety systems, security systems, communication systems etc. Requirements for these systems are detailed in the relevant section dealing with that system.

2F-2 DEFINITIONS

Refer to Section 2E / Section 1B of this specification and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

Additional definitions specifically associated with inspection and testing are as follows:-

Departure – Deliberate decision not to comply fully with the requirements of BS 7671 for which the designer must declare that the resultant degree of safety is not less than that achievable by full compliance.

EIC – Electrical Installation Certificate.

EICR – Electrical Installation Condition Report (formerly known as Periodic Inspection Report).

Inspector – Refers to the person(s) employed by the Contractor responsible for undertaking the inspection and testing works.

Qualified Supervisor – Refers to the person employed by the Contractor responsible for overseeing the inspection and testing works. They shall also be responsible for the review and verification of the certification and/or reports.

The Inspector may also be the Qualified Supervisor.

Non-compliance – A non-conformity that may give rise to danger.

New Installation Works – Refers to new installation work, and for alterations or additions to existing installations where new circuits have been introduced. This includes the replacement of existing electrical switchgear such as low voltage switch panels, MCCB panel boards, MCB distribution boards, consumer units etc.

Where referenced within this documentation Electrical Installation Condition Reports (EICR) shall mean the same as Periodic Inspection Reports (PIR), which is an obsolete term still commonly used.

2F-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS AND DOCUMENTS	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations – Part 6 Inspection and Testing
IET On-Site Guide – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations – Section 9 Inspection and testing and Section 10 Guidance on initial testing of installations and Section 11 Operation of RCDs	
IET Guidance Note 3 – Inspection & Testing	
BS 5458	Specification for safety requirements for indicating and recording electrical measuring instruments and their accessories (Superseded / withdrawn and replaced by BS EN 61010, this is the standard to which some older instruments that are still in use should have been manufactured)
BS EN 61010	Safety requirements for electrical equipment for measurement, control, and laboratory use
BS EN 61243	Live working – Voltage detectors
BS EN 61557	Electrical safety equipment in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing; measuring or monitoring of protective measures
HSE (Health and Safety Executive) – Guidance Note GS38 – Electrical test equipment for use on low voltage electrical systems	
HSE (Health and Safety Executive) – The Electricity at Work Regulations – Guidance on regulations – HSR25	
HSE (Health and Safety Executive) – Electricity at Work – Safe working practices – HSG85	
Electrical Safety First – Best Practice Guide 2 – Guidance on the management of electrical safety and safe isolation procedures for low voltage installations	
Electrical Safety First – Best Practice Guide 7 – Test instruments for electrical installations: Accuracy and consistency	
NICEIC / ECA / ELECSA – Inspection, Testing and Certification including Periodic Reporting – Practical advice and guidance	
All standards, guidance and statutory regulations detailed within Section 2E-3	

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Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

2F-4 STATUTORY REGULATIONS AND BS 7671 IET WIRING REGULATIONS

All persons undertaking the inspection and testing of electrical installations shall comply with relevant requirements of The Electricity at Work Regulations, where particular attention shall be paid to Regulation 12 "Means for cutting off the supply and for isolation' and Regulation 14 'Work on or near live conductors' and the guidance provided by the HSE (Health and Safety Executive) – Memorandum of guidance on the Electricity at Work Regulations 1989 – Guidance on regulations – HSR25.

The electrical inspection and testing shall be undertaken in accordance with the latest version of BS 7671 IET Wiring Regulations – Requirements for Electrical Installations and all supporting IET documentation.

The Contractor shall be fully responsible for the inspection and testing of the electrical installation, which shall only be undertaken by one or more skilled persons (electrically) as defined in BS 7671 that are competent to undertake the works in such an installation.

Precautions shall be taken to ensure that the inspection and testing of the electrical installation shall not cause danger to persons or livestock and shall not cause damage to property and equipment even if a circuit is defective.

2F-5 ELECTRICAL CONTRACTING CERTIFICATION SCHEMES

The Contractor shall undertake all inspection and testing in accordance with industry best practice and must be registered with an appropriate certification scheme as detailed in Section 2E of this specification. The inspection and testing of the electrical installation shall only be undertaken by persons who meet the minimum requirements to undertake the works as defined by their Electrical Contracting Certification Scheme.

This shall be the National Inspection Council for Electrical Installation Contracting (NICEIC) / ELECSA – Platinum Promise registration scheme, or equivalent.

The Contractor shall directly employ a Qualified Supervisor / Inspector on a full time basis as required by their Electrical Contracting Certification Scheme. The Qualified Supervisor / Inspector shall also meet the minimum requirements as defined by their Electrical Contracting Certification Scheme e.g. relevant education and experience, hold a recognised inspection and testing qualification etc.

The Qualified Supervisor shall oversee the testing and inspection works and shall ensure that the results of inspection and testing are recorded correctly on the appropriate certificates and/or reports. The Qualified Supervisor shall also be responsible for the review, verification, signing and dating of the certification and/or reports.

The person(s) undertaking the inspection and testing works (Inspector) may also be the Qualified Supervisor.

All due allowances shall be made within the tender submission for the Qualified Supervisor and the person(s) undertaking the inspection / testing works (Inspector) to meet on-site when requested by the Engineer at a mutually agreeable time.

2F-6 CERTIFICATION AND REPORTS

Dependent upon the type of works undertaken, certification and reports shall be provided as required by BS 7671 and Electrical Contracting Certification Schemes.

The certification and reports shall be selected from below as required:-

ELECTRICAL INSTALLATION CERTIFICATES

The EIC shall be used for all new installation work, and for all alterations or additions to existing installations where new circuits have been introduced including the replacement of existing main electrical switchgear such as low voltage switch panels, MCCB panel boards, MCB distribution boards, consumer units etc.

The EIC shall include:-

1) Front matter.
2) Schedule of items inspected.
3) Schedule of additional records (these shall be defined and allocated page numbers within the certification e.g. fire alarm system, emergency lighting etc.).
4) Schedule of circuit details.
5) Schedule of test results for every circuit.

It shall not be used for the inspection and testing of an existing electrical installation, where an EICR shall be used.

DOMESTIC ELECTRICAL INSTALLATION CERTIFICATES

The Domestic Electrical Installation Certificate shall be used for all new electrical installation work, and for all alterations or additions to existing installations where new circuits have been introduced including the replacement of existing main electrical switchgear such as MCB distribution boards, consumer units etc.

The certificate shall only be used for new installation work where all of the following conditions apply:-

1) The electrical installation work relates to a single dwelling (house or individual flat).
2) The design, the construction, and the inspection and testing of the electrical installation work are the responsibility of one Contractor with approval by an Electrical Contracting Certification Scheme.
3) The installation forms part of a TT, TN-S or TN-C-S (PME) system.
4) The protective measure for fault protection is provided primarily by Automatic Disconnection of Supply.

The Domestic Electrical Installation Certificate shall include:-

1) Front matter.

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2) Schedule of items inspected.

3) Schedule of circuit details.

4) Schedule of test results for every circuit.

It shall not be used for single dwellings where the Engineer is responsible for the design, as the Domestic Electrical Installation Certificate does not include a separate 'DESIGN' section. An EIC shall be used instead.

MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATES

The Minor Electrical Installation Works Certificate shall be used for any alteration or addition to an existing circuit such as:-

1) Addition of a socket-outlet to a ring or radial circuit.

2) Additional of a lighting point.

3) Alterations to lighting switching such as relocation of light switches.

4) Replacement of an accessory or luminaire (not switchgear such as DB's etc.).

It shall not be used for new circuits or the replacement of existing main electrical switchgear e.g. MCB distribution boards, consumer units etc. Further reference shall be made to Electrical Contracting Certification Schemes to clarify the acceptable and non-acceptable works associated with Minor Electrical Installation Certificates.

ELECTRICAL INSTALLATION CONDITION REPORTS (FORMERLY PERIODIC INSPECTION REPORTS)

The EICR shall only be used for reporting on the condition of an existing installation.

The EICR shall include:-

1) Front matter.

2) Schedule of observations and recommendations for actions to be taken.

3) Inspection schedule for distribution boards and circuits.

4) Schedule of test results for every circuit (unless defined sample rates have been provided).

It shall not be used for new installation work.

The agreed extent of the installation covered by the periodic inspection and testing along with any agreed limitations shall be clearly defined and recorded within the EICR. Where agreed periodic inspection and testing sample rates have been applied these shall be clearly defined and recorded within the EICR.

These should be recorded within the 'Extent of the Installation and Limitations on the Inspection and Testing' within the EICR.

GENERAL REQUIREMENTS FOR CERTIFICATION AND REPORTS

The general requirements for certification and reports are as follows:-

1) For new installation work, any defect or omission revealed during the inspection and testing shall be corrected before the certification is issued.

2) For any alterations and/or additions to an electrical installation, any defect or omission that will affect the safety of the alteration or addition that is revealed during inspection and testing shall be corrected before the certification is issued.

   The Contractor responsible for the alteration or addition shall record on the certification any other defects observed during the course of the works that may give rise to danger.

3) For all new installation work, and for all alterations or additions to existing installations where new circuits have been introduced, the certification shall include a recommendation for the interval between initial verification and the first periodic inspection e.g. 'NEXT INSPECTION' entry box.

4) Where parts of an existing installation are not required to be inspected and tested (i.e. do not form part of the works) any observed departures or non-compliances shall be recorded within the 'COMMENTS ON THE EXISTING INSTALLATION' section of the certification.

5) Where existing circuits have not been modified but have been disconnected and re-terminated (e.g. existing final circuits into new or existing MCB distribution boards etc.) they shall be fully inspected and tested as required by BS 7671.

6) They must be completed in accordance with BS 7671, IET Guidance Note 3 and Electrical Contracting Certification Schemes.

7) All entry boxes must be completed and contain accurate information. Where an entry box is not applicable to the works that have been undertaken 'N/A' shall be used.

8) When incomplete they are deemed to be invalid by Electrical Contracting Certification Schemes.

9) All switchgear / equipment reference numbers, circuit references and final circuit references shall be coordinated throughout and be the same as those used in the specification schedules / drawings.

10) Where a location is to be defined it shall be co-ordinated with the architectural drawings and the site room referencing system.

11) Where a documented risk assessment has determined that RCDs are not required as additional protection for socket outlets with a rated current not exceeding 32A, this shall be noted within the 'DESIGN' section and the documented risk assessment shall be appended.

12) 'Schedules of additional records' relating to the electrical installation shall be included and their respective page numbers shall be identified (e.g. fire alarm system, emergency lighting etc.). The requirements for these are detailed in subsequent sections of this specification.

13) The 'Circuit line and number' included within the 'Schedule of test results' shall be co-ordinated with the 'Schedule of circuit details'. The 'Schedule of test results' shall include test results for every circuit tested.

14) The Contractor / Qualified Supervisor shall be responsible for the review, verification, signing and dating of the certification and/or reports. This shall take into account their respective responsibilities e.g. 'CONSTRUCTION', 'INSPECTION AND TESTING', 'DESIGN, CONSTRUCTION, INSPECTION AND TESTING' entry boxes as necessary.

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15) On completion they shall be issued to the Engineer for comment. When responsible for the design of the electrical installation the Engineer shall sign and date the 'DESIGN' entry box.

16) They shall be provided as part of the Operation and Maintenance Manual and Health and Safety File as required by the Construction (Design and Management) Regulations.

17) Schedules / charts shall be provided to all:-

a) Low voltage switch panels.

b) MCCB panel boards.

c) MCB distribution boards.

d) Consumer units.

As detailed within Section 2E of this specification.

2F-7 INSPECTION

The electrical installation shall be inspected to ensure all electrical equipment and materials are of the correct type and comply with the appropriate British or Harmonised Standard, or International (IEC) Standard.

The inspection shall verify that the electrical installation:

1) Has been correctly selected and erected in accordance with BS 7671, all supporting IET documentation and manufacturers' instructions.

2) Is not visibly damaged or defective or has deteriorated (existing installations) so as to impair safety.

3) Is ready and safe to be used.

The electrical installation shall be inspected throughout the installation period with particular attention paid to any electrical services that may become inaccessible upon completion e.g. concealed cable support and containments systems, cabling, accessories, busbar trunking and power track systems etc. etc.

On completion of the electrical installation works a further inspection shall be undertaken prior to any electrical testing (dead or live testing) taking place.

Appendix I of this section provides an Electrical Installation Certificate checklist of some of the principal items that shall be inspected as a minimum. However it shall be noted that the checklist is not exhaustive and is provided as a guide. The items included within the schedule shall form the Schedule of Inspections to be included with the certification / reports.

The inspection guidance provided in IET Guidance Note 3 Inspection and Testing shall also be followed:

1) Section 2.5.2 Comments on individual items to be inspected.

2) Section 2.5.3 Inspection checklist.

All items shall also be inspected that are included on the 'Schedules of Items Inspected' list that form part of the certification required by Electrical Contracting Certification Schemes. All entry boxes on the schedules must be completed:

- '✓' shall indicate that an inspection was undertaken and the result was satisfactory.
- 'N/A' shall indicate that an inspection was not applicable to the installation.

Joint formal inspections shall be undertaken at a mutually agreeable time by the Qualifying Manager, the person(s) undertaking the inspection / testing works and the Engineer.

Any departures from or non-compliances with the requirements of this specification and BS 7671 as a result of inspection(s) must be rectified at no additional cost and in a timely manner to suit the construction programme.

2F-8 TEST EQUIPMENT

Test instruments shall be selected in strict accordance with the performance standards detailed in BS EN 61557 and the safety requirements of BS EN 61010. Test instruments shall also be selected to meet the instrument accuracy and performance criteria detailed within IET Guidance Note 3 Inspection and Testing.

A system shall be in place to ensure the accuracy of test instruments as required by Electrical Contracting Certification Schemes.

As a minimum the accuracy of test instruments shall be confirmed by formal calibration / re-calibration at intervals recommended by the manufacturer and shall be supported by calibration certificates provided by laboratories accredited by the United Kingdom Accreditation Service (UKAS).

More frequent re-calibrations may be required if test instruments are exposed to changes in temperature / humidity and also if they are roughly handled and regularly transported / stored in vehicles. It shall be the Contractor's responsibility to ensure that the test instruments meet the required accuracy and performance criteria prior to testing.

The model and serial number for each test instrument shall be recorded on the certification, reports and schedules. A copy of the calibration certificate for each test instrument shall be provided as part of the Operation and Maintenance Manual.

Voltage indicators, test probes, clips and leads shall be selected and used in accordance with the guidance outlined in HSE – Guidance Note GS38.

2F-9 ISOLATION

Inspection and dead testing shall be undertaken with the appropriate part of the installation disconnected from the electrical supply by some form of isolation. The isolation of the electrical supply shall be undertaken in accordance with the guidance outlined in HSE – Electricity at Work – Safe working practices – HSG85.

As a minimum the isolation of the electrical supply shall be verified by the following safe working procedure:-

1) Step 1 – Open the means of isolation and secure the isolation device.

2) Step 2 – Prove the correct operation of the voltage detector / indicator to be used against a known source such as a voltage proving unit.

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3) Step 3 – Test all conductors (including protective conductors in case there is a wiring fault) to verify that no dangerous voltage is present and the circuit(s) is safe to be worked upon.

4) Step 4 – Prove the correct operation of the voltage detector / indicator to verify that it was functioning correctly when the circuit(s) where tested.

Inspection and testing shall be undertaken in such a way as to minimise disturbance of the installation and inconvenience to the user.

Where it is necessary to disconnect part or the whole of the installation in order to carry out a test, the disconnection should be made at a time agreed with the Client and for the minimum period needed to carry out the test. Where more than one test necessitates a disconnection, where possible they should be made during one disconnection period.

All shutdowns and disconnections must be agreed with the Client prior to works commencing.

2F-10 TESTING SEQUENCE

The sequence of testing and test methods shall be undertaken in strict accordance with BS 7671, IET Guidance Note 3 Inspection and Testing and the NICEIC / ECA / ELECSA – Inspection, Testing and Certification including Periodic Reporting – Practical advice and guidance.

For new installation works the sequence of initial testing shall be as detailed below (where applicable):-

DEAD TESTING

Before the supply is connected, or with the supply disconnected as appropriate:-

1) Continuity of protective conductors, including main and supplementary equipotential bonding.
2) Continuity of ring final conductors (where present).
3) Insulation resistance.
4) Protection by SELV, PELV or by electrical separation.
5) Basic protection provided by a barrier or an enclosure provided during erection.
6) Insulation resistance / impedance of floors and walls.
7) Polarity.
8) Earth electrode resistance (dependent upon the test method used this may be a live test).

LIVE TESTING

With the supply connected:-

1) Protection by automatic disconnection of supply.
2) Earth fault loop impedance.
3) Prospective fault current.
4) Check of phase sequence.
5) Operation of residual current devices (the test to be independent of any test facility incorporated in the device).
6) Functional testing of residual current devices (RCDs).
7) Functional testing of arc fault detection devices (AFDDs).
8) Other functional testing e.g. functional testing of switchgear and control gear assemblies, drives, controls, interlocks etc.

2F-11 TESTING PROCEDURES

An overview of the testing procedures is provided below:

CONTINUITY OF PROTECTIVE CONDUCTORS, INCLUDING MAIN AND SUPPLEMENTARY EQUIPOTENTIAL BONDING

This is the measurement of one of the following to verify the continuity of the circuit protective conductors:

- Resistance of $R_1 + R_2$ (Test method 1 of BS 7671 – $R_1 + R_2$ method).
- R_2 (Test method 2 of BS 7671 – Wander lead method).

The measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. The measurement at the extremity of the circuit (furthest point) for $R_1 + R_2$ in Ω (ohms) shall be recorded on the Schedule of Test Results. The measurements shall verify that electrical continuity has been achieved and confirm correct polarity (✓) for the circuit.

Testing shall also be undertaken to verify the electrical continuity of all bonding conductors and earthing conductors.

All metallic cable support and containment systems shall be equipotential bonded for protective earthing and to avoid / reduce electromagnetic disturbances as detailed within Section 2E of this specification. Test method 2 shall be used to measure the resistance across all joints to verify electrical continuity. The measured resistance across joints shall not exceed 0.05 Ω.

The electrical continuity of cable support and containment systems shall also be verified in accordance with their respective standards, as detailed later within this section of the specification.

Test method 2 shall also be used to verify there is a bonding connection between extraneous conductive parts where it is not possible to see the bonding connection (e.g. where bonding clamps are 'built in' to metallic pipework). The measured resistance shall not exceed 0.05 Ω.

CONTINUITY OF RING FINAL CIRCUIT CONDUCTORS

This is the measurement of:

1) Step 1:- The resistance of r1, r2 and rn to verify the continuity of all conductors.
2) Step 2:- Having made the L-N cross connection, the resistance between line and neutral conductors at each outlet to verify the resistance is substantially the same at each outlet and equates to (r1 + rn) / 4, (subject to outlets wired as spurs from the ring final circuit).

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3) Step 3:- Having made the L-E cross connection, the resistance between line and earth at each outlet to verify the resistance is substantially the same at each outlet and equates for (r1 + r2) / 4, (subject to outlets wired as spurs from the ring final circuit).

The measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. The measurements for r_1, r_2 and r_n in Ω (ohms) shall be recorded on the Schedule of Test Results. The highest value of resistance recorded from Step 3 is also to be recorded on the Schedule of Test Results as the $R_1 + R_2$ measurement.

The measurements shall verify that electrical continuity has been achieved and confirm correct polarity (✓) for the circuit.

INSULATION RESISTANCE

This is the measurement of the insulation resistance between all of the live conductors and between each live conductor and the protective conductor, to verify that the insulation of conductors provides adequate electrical insulation, is not damaged and that live conductors or protective conductors are not short-circuited.

Voltage sensitive electronic equipment such as RCBOs, surge protective devices, dimmer switches, touch switches, timers, controllers etc. shall be temporarily disconnected so they are not subjected to the test voltage.

The measurements are to be made by applying an appropriate test voltage as indicated below, using an insulation resistance tester or by selecting the appropriate range on a multi-function tester:-

CIRCUIT NOMINAL VOLTAGE (V)	TEST VOLTAGE D.C. (V)	MINIMUM INSULATION RESISTANCE VALUE (MΩ)
SELV and PELV	250	0.5
Up to and including 500 V with the exception of SELV and PELV but including FELV	500	1.0
Above 500 V	1000	1.0

The resistance measurements in MΩ (e.g. >200 MΩ) shall be shall be recorded on the Schedule of Test Results for:-

1) Line / Line.
2) Line / Neutral.
3) Line / Earth
4) Neutral / Earth.

The measurements shall be verified against the minimum acceptable insulation resistance values required by BS 7671 which are also detailed in the above table. For new installation works the following are to be brought to the attention of the Engineer immediately in writing:-

1) Any values recorded below 20 MΩ (which are above the minimum requirements outlined in BS 7671).
2) Where measured values show evident differences between similar circuits.

It is also recommended that insulation resistance testing is undertaken at various stages during the installation works to prove the integrity of the cables and to prevent remedial works towards the end of the contract.

The insulation resistance testing of socket outlets with integral USB (Universal Serial Bus) charging ports shall be undertaken in accordance with manufacturers' recommendations. Generally the measurements shall be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester.

The measurements shall not be less than 1.0 MΩ (as opposed to 0.5 MΩ for SELV and PELV circuits) which is the minimum acceptable insulation resistance value required by BS 7671 where it is not reasonably practical to disconnect the socket outlets.

PROTECTION BY SELV, PELV OR BY ELECTRICAL SEPARATION

1) Protection by SELV, where SELV is used as a protective measure and insulation testing is required.
   a) Basic insulation test

      This is the measurement of the insulation resistance between line conductors and all other circuits including other SELV, PELV and low voltage circuits.

   b) Line to Earth insulation test:

      This is the measurement of the insulation resistance between all SELV line parts and earth.

The measurements are to be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 0.5 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

2) Protection by PELV, where PELV is used as a protective measure and insulation testing is required.
   a) Basic insulation test:-

      This is the measurement of the insulation resistance between line conductors and all other circuits including other SELV, PELV and low voltage circuits.

The measurements are to be made by applying a test voltage of 250 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 0.5 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

3) Protection by electrical separation.
   a) Basic insulation test:

      This is the measurement of the insulation resistance between the electrically separated live conductors and the transformer secondary live conductors.

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b) Basic insulation of the separated conductors:-

This is the measurement of the insulation resistance between the electrically separated live conductors and their corresponding exposed-conductive-parts.

c) Basic insulation of any exposed-conductive-parts associated with separated conductors:-

This is the measurement of the insulation resistance between the any exposed-conductive-parts associated with the electrically separated circuits and any protective conductor, other exposed-conductive-parts or Earth.

The measurements are to be made by applying a test voltage of 500 V d.c. using an insulation resistance tester or by selecting the appropriate range on a multi-function tester. The measurements shall not be less than 1 MΩ which is the minimum acceptable insulation resistance value required by BS 7671.

Additional inspections and tests shall also be undertaken for separated circuits supplying more than one item of current using equipment as required by IET Guidance Note 3 Inspection and Testing. This is to verify that two coincidental faults with negligible impedance will disconnect one of the faulty circuits within the disconnection time required by BS 7671.

BASIC PROTECTION BY A BARRIER OR AN ENCLOSURE PROVIDED DURING ERECTION

These tests only apply to barriers or enclosures constructed on-site during the installation works and do not apply to the barriers or enclosures of factory-built equipment.

Barriers and/or enclosures shall be provided to prevent contact with live parts and shall provide at least the degree of protection (IP code) of IPXXB or IP2X. However a horizontal or top surface of a barrier or enclosure which is readily accessible shall provide at least the degree of protection (IP code) of IPXXD or IP4X.

This is to verify that each barrier / enclosure gives adequate protection against the risk of electric shock through contact with live parts by fingers or foreign objects (e.g. conductive tools).

These degrees of protection shall be tested as follows:-

1) IP2X is defined in BS EN 60529 as protection against the entry of 'Fingers or similar objects not exceeding 80mm in length. Solid objects not exceeding12.5mm in diameter':-

   The test is made with a metallic standard test finger (test finger 1 to BS EN 61032).

2) IP4X is defined in BS EN 60529 as protection against the entry of 'Wires or strips of thickness greater than 1.0mm, and solid objects of 1.0mm diameter or greater':-

The test is made with a straight rigid steel wire of 1.0mm diameter applied with a force of 1 N ± 10 per cent.

INSULATION RESISTANCE / IMPEDANCE OF FLOORS AND WALLS

These tests are not required for standard electrical installations however if required reference shall be made to IET Guidance Note 3 Inspection and Testing.

POLARITY

Polarity testing shall verify:-

1) The polarity of the supply shall at the origin of the installation before the installation is energized.
2) That where single-pole switching devices are not permitted in the neutral conductor the devices are connected in the line conductor(s) only.
3) The wiring has been correctly connected throughout the installation.

Polarity of circuits shall be verified by the visual inspection of all termination points (by checking the core colours) or the measurement of the resistance of $R_1 + R_2$.

Polarity may be verified during the process of testing by:

1) Continuity of protective conductors – Test method 1 ($R_1 + R_2$ method).
2) Continuity of ring final circuit conductors.

Where polarity is verified during the process of testing the measurements are to be made by using a low-resistance ohmmeter or by selecting the appropriate range on a multi-function tester. Upon verification a '✓' shall be recorded on the Schedule of Test Results.

EARTH ELECTRODE RESISTANCE

This is the measurement of the resistance of earth electrodes to verify the resistance is low enough to assist with disconnection times.

One of the following test methods shall be used:-

1) Test method E1: Measurement using dedicated earth electrode tester (fall of potential, three- or four-terminal type)

   The entire installation must be isolated from the supply before the means of earthing is disconnected to perform this test. On completion of testing all bonding and protective conductors must be reconnected prior to the installation being energised (or re-energised).

2) Test method E2: Measurement using dedicated stakeless or clamp-based earth electrode tester.

   The earth electrode under test does not need to be disconnected for this method.

3) Test method E3: Measurement using an earth fault loop impedance tester.

   (Effectively the same method used for testing external earth fault loop impedance Ze).

   The entire installation must be isolated from the supply before the means of earthing is disconnected to perform this test. It shall be noted this method is a live test and the supply shall be re-energised to perform the testing. On completion of testing the supply shall be isolated and all bonding and protective conductors must be reconnected prior to the installation being re-energised.

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Generally the measurement shall verify that the earth electrode resistance is less than 200 Ω, however the required automatic disconnection times of RCDs shall also be verified for TT systems. Earth electrode resistance values above 200 Ω may not be stable due to ground conditions.

The measurement of earth electrode resistance R_A shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report. Also the earth electrode type, location and the method of measurement shall be recorded.

PROTECTION BY AUTOMATIC DISCONNECTION OF SUPPLY

The effectiveness of measures for fault protection by automatic disconnection of supply shall be verified for TN systems as follows:-

1) Measurement of earth fault impedance.
2) Visual inspection to confirm that protective devices are suitable.

   (e.g. correct setting, type and ratings for circuit breakers and correct type and ratings for fuses).
3) Where used, RCD testing to confirm disconnection times are achieved.

For TT and IT systems reference shall be made to BS 7671 and IET Guidance Note 3 Inspection and Testing.

EARTH FAULT LOOP IMPEDANCE

Electrically continuity testing (as detailed earlier) must have been undertaken prior to the commenced of any earth fault loop impedance measurements.

This is the measurement of earth fault loop impedance (Z_S) to verify that when an earth fault occurs the resistance of the earth fault loop ($Z_s = R_1 + R_2 + Z_e$) shall be low enough for a large fault current to flow and operate a protective device in the required disconnection time, therefore achieving automatic disconnection of the circuit line conductor.

Note: Z_e may be substituted with Z_{db} when testing at a downstream distribution board or similar as the value measured is not external to the installation.

One of the following test methods shall be used:-

1) Measurement of total earth fault loop impedance (Z_S) using an earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester. It shall be noted that the measured Z_S may be less than R1 + R2 + Ze due to parallel earth return paths.
2) Measurement of (R1 + R2) during continuity testing using a low-resistance ohmmeter and addition to the measured external fault loop impedance (Ze) of the same circuit, using an earth fault loop impedance tester.

The latter method is preferred when determining Z_S for final circuits and distribution circuits.

The measurement at the extremity of the circuit (furthest point) for Z_S in Ω (ohms) shall be recorded on the Schedule of Test Results. For ring final circuits the earth fault impedance (Z_S) shall be measured at every outlet / point and the highest value measured shall be recorded on the Schedule of Test Results.

The measurements shall be verified against the maximum earth fault loop impedance (Z_S) values required by BS 7671 which must be adjusted for temperature by applying a factor of 0.8 (80%).

e.g. for a 20A Type B circuit breaker to BS EN 60898, BS 7671 provides a maximum earth fault loop impedance of 2.19 Ω. However, this is at operating temperature, so the maximum acceptable measured value shall be 2.19 x 0.8 = 1.752 Ω.

It shall be noted that adjusted for the industry recognised 0.8 'rule of thumb' are contained within the IET On-Site Guide / IET Guidance Note 3 and can also be obtained from Electrical Contracting Certification Schemes, which can then be used for verification of measurements.

Under no circumstances shall the measurements be verified against the maximum earth fault loop impedance (Z_S) contained within BS 7671 with no adjustment for temperature.

The maximum permitted earth fault loop impedance (Z_S) values included within the 'Maximum Z_s permitted by BS 7671' column of the 'Schedule of circuit details' shall include the Z_S values from BS 7671 which have not been adjusted for temperature.

Where supplementary protective equipotential bonding has been provided to satisfy the measured earth fault loop impedance requirements of BS 7671, the effectiveness of the bonding shall be verified.

The external fault loop impedance (Z_e) shall also be measured to verify there is an earth connection and to determine the external earth fault loop impedance (Z_e) which is part of the earth fault loop (Z_s).

The external fault loop impedance (Z_e) shall be measured at:-

1) The origin of the installation.

   The measurement for Z_e in Ω (ohms) shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report.
2) At each item of switchgear within the installation (e.g. LV switch panels, MCCB panel boards, MCB distribution boards, consumer units etc. etc.)

   The measurement for Z_S (sometimes known as Z_s, Z_{db} or similar) in Ω (ohms) shall be recorded on the Schedule of Test Results (top section) for the item of switchgear.

The measurements are to be made by using an earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester.

PROSPECTIVE FAULT CURRENT

This is the measurement of prospective fault current (I_{pf}) under both short-circuit and earth fault conditions to verify that the rated short-circuit breaking capacities of protective devices are greater than the prospective fault current (I_{pf}).

The prospective short circuit current and prospective earth fault current shall be measured at every relevant point of the installation which includes:-

1) The origin of the installation.

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The measurement for I_{pf} in kA shall be recorded in the Supply Characteristics and Earthing Arrangements section of the certification / report.

2) At each item of switchgear within the installation where a protective device is required to operate under fault conditions.

The measurement for Ipf in kA shall be recorded on the Schedule of Test Results (top section) for the item of switchgear.

The measurements are to be made by using the prospective fault current range of a suitable earth fault loop impedance tester or by selecting the appropriate range on a multi-function tester. Whichever is the greater measurement of prospective short circuit current (PSCC) and prospective earth fault current (PEFC) shall be recorded.

For three phase supplies where a 230V test instrument is used the prospective fault current line to line can be taken as twice that of the prospective fault current line to neutral.

e.g. line to neutral measurement of 4.6 kA x 2 = 9.2 kA (I_{pf}).

The measurements shall be verified by comparing the measured prospective fault current (I_{pf}) at the terminals of protective devices with their rated short-circuit breaking capacities. The rated short-circuit breaking capacities of protective devices must be greater than the prospective fault current (I_{pf}).

CHECK OF PHASE SEQUENCE

Generally this is verified by checking the polarity and connections at all relevant points throughout the installation. However the phase sequence of all three phase equipment such as rotating machines (e.g. motors) shall be verified to ensure correct rotation. This shall be verified by using a phase rotation tester or by selecting the appropriate range on a multi-function tester.

ADDITIONAL PROTECTION – OPERATION OF RESIDUAL CURRENT DEVICES

This is the measurement of RCD (RCCB or RCBO) operating times to verify the correct operation and required disconnection times are achieved. The measurements are to be made by using an RCD tester or by selecting the appropriate range on a multi-function tester. Loads shall be disconnected during testing. All residual current devices shall be tested at:-

1) 50% of the rated operating (tripping) current and shall not operate / open.

2) 100% of the rated operating (tripping) current (IΔn) and shall operate / open.

The measured operating time in ms shall be recorded (where applicable) in the:

a) Particulars of Installation at the Origin section of the certification / report. If the residual current device has a rated time delay this shall also be included.

b) Schedule of Test Results (top section) for the item of switchgear.

c) Schedule of Test Results for a circuit.

The residual current devices shall have an operating time not exceeding that required by their respective product standards at a residual current of IΔn, as detailed in the table below:-

DEVICE TYPE	NON-TIME DELAYED	WITH TIME DELAY	NOTES
	MAXIMUM OPERATING TIME AT 100% RATED TRIPPING CURRENT, IΔn (ms)	OPERATING TIME AT 100% RATED TRIPPING CURRENT, IΔn (ms)	
BS 4293	200	((0.5 to 1.0) x time delay) + 200	
BS 61008	300	130 to 500	S type
BS 61009 (RCBO)	300	130 to 500	S type
BS 7288 (integral socket-outlets)	200	Non-applicable	

Residual current devices used for additional protection shall also be tested at 5 IΔn (e.g. 150mA for IΔn = 30mA) and the measured operating time in ms shall be recorded in the:-

1) Schedule of Test Results (top section) for the item of switchgear (if applicable).

2) Schedule of Test Results for a circuit.

Residual current devices for additional protection shall have an operating time not exceeding 40ms at a residual current of 5 IΔn.

Measurements shall be taken on both positive and negative half cycles of the supply waveform and the longer operating time shall be recorded.

ADDITIONAL PROTECTION – SUPPLEMENTARY PROTECTIVE EQUIPOTENTIAL BONDING

Where supplementary protective equipotential bonding has been provided for additional protection the effectiveness of the bonding shall be verified.

FUNCTIONAL TESTING OF RESIDUAL CURRENT DEVICES

Functional testing shall be undertaken on all residual current devices. The integral test device shall be operated by pressing the button marked 'T' or 'Test', during testing the residual current devices must be energised.

Upon verification a '✓' shall be recorded on the Schedule of Test Results.

FUNCTIONAL TESTING OF ARC FAULT DETECTION DEVICES (AFDDs)

Functional testing shall be undertaken on arc fault detection devices (AFDDs) when they are provided with a manually operated test facility, in strict accordance with the manufacturers' recommendations.

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Upon verification a '✓' shall be recorded on the Schedule of Test Results.

AFDDs that do not have a manually operated test facility cannot be tested for functionality.

OTHER FUNCTIONAL TESTING

All equipment that forms part of the electrical installation shall be subjected to functional testing to verify that it functions correctly and has been properly mounted, adjusted, and installed in accordance with BS 7671.

This shall include:

1) All electrical switchgear used for isolation e.g. main switches, isolators, protective devices etc.
2) All luminaires, switching and control devices, interlocks, adjustable relays, socket-outlets etc.
3) Motors, motor controls and starters, including correct rotation.

It shall be noted the above list is not exhaustive and functional testing must be undertaken on all equipment that forms part of the electrical installation.

2F-12 DEPARTURES FROM AND NON-COMPLIANCES WITH BS 7671

Any departures from or non-compliances with BS 7671 resulting from the inspection and testing of the electrical installation shall be brought to the attention of the Engineer immediately in writing.

2F-13 INSPECTION AND TESTING OF MEDICAL INSTALLATIONS

This section of the specification details the general inspection and testing requirements that shall also apply to medical installations. However it shall be noted that medical installations will have additional inspection, testing and commissioning requirements, for example (but not limited to):

1) Inspection and functional tests of medical IT systems.
2) Measurement of the leakage current for the output circuit and the enclosure of medical IT system isolating transformers.
3) Measurement of the resistance of protective conductors between the earth terminals of any socket outlet (or fixed equipment) and any extraneous conductive parts (e.g. not exceeding 0.2 Ω for Group 1 and 2 locations etc.).

Medical IT systems are also known as medical isolated power supply systems.

Where required the inspection and testing requirements of medical installation shall be detailed within a subsequent section of this specification.

2F-14 CONTINUITY OF CABLE SUPPORT AND CONTAINMENT SYSTEMS

All metallic cable support and containment systems shall be equipotential bonded for protective earthing and to avoid / reduce electromagnetic disturbances as detailed within Section 2E of this specification.

The electrical continuity of cable support and containment systems shall be tested as follows:-

1) Cable ladder rack, cable tray and cable basket shall be tested in accordance with the relevant clauses of BS EN 61537.
2) Cable trunking shall be tested in accordance with the relevant clauses of BS EN 50085.
3) Cable conduit shall be tested in accordance with the relevant clauses BS EN 61386.

It shall also be verified that all connections between cable conduit (e.g. conduit take-off plates, conduit boxes) and cable tray / basket / tray have adequate electrical continuity.

The Contractor shall provide written clarification that the cable support and containment systems have electrical continuity characteristics as defined in the above standards.

2F-15 FIRE BARRIERS / STOPPING

On completion of the fire barriers / stopping works fully detailed completion / compliance certification shall be provided along with record drawings that detail all fire barrier / stopping locations.

2F-16 FACTORY BUILT ASSEMBLIES

The Engineer shall be afforded the opportunity to inspect and formally witness the testing of all bespoke factory built assemblies (e.g. LV switch panels, switchgear etc.) before they are dispatched to site. The required period of notice to attend shall normally be 10 days, but shall be variable at the discretion of the Engineer.

The Engineer shall be provided with a copy of the appropriate inspection and testing certification for each factory built assembly which shall also be included within the Operation and Maintenance Manual.

2F-17 THERMOGRAPHIC SURVEYS

Any requirement for undertaking thermographic surveys shall be detailed within a subsequent section of this specification. The guidelines on thermographic equipment shall be followed within IET Guidance Note 3.

2F-18 FORMAL WITNESSING OF TESTING

The Qualified Supervisor and the person(s) undertaking the inspection / testing works shall give reasonable notice of all tests to permit them to be witnessed by the Engineer. The required period of notice shall normally be 10 days, but shall be variable at the discretion of the Engineer.

Preliminary testing shall be undertaken prior to any formal witnessing by the Engineer. The preliminary test results shall be provided to the Engineer in draft certificates before inviting the Engineer to attend formal witnessing. The Engineer will then witness the formal tests in full or selectively as deemed necessary to verify the draft test results.

The proportion of tests to be witnessed by the Engineer will be 20%, though this could be reduced to 10% at the discretion of the Engineer on very large systems. The Engineer has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful e.g. the test readings cannot be repeated within a reasonable degree of accuracy. In this instance the Electrical Contractor shall bear all costs associated with this additional work.

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2F-19 APPENDIX I – SCHEDULE OF INSPECTIONS (CHECKLIST)

SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)			
1.0	**CONDITION OF ELECTRICAL INTAKE EQUIPMENT (the Distributor should be notified of any unsatisfactory equipment)**		
1.1	Service cable		
1.2	Service head		
1.3	Earthing arrangement		
1.4	Meter tails – Distributor / Consumer		
1.5	Metering equipment		
1.6	Isolator		
2.0	**PARALLEL OR SWITCHED ALTERNATIVE SOURCES OF SUPPLY**		
2.1	Presence of adequate arrangements where generator to operate as a switched alternative		
	a)	Dedicated earthing arrangement independent of that of the public supply	
2.2	Presence of adequate arrangements where generator to operate in parallel with public supply system		
	a)	Correct connection of generator in parallel	
	b)	Compatibility of characteristics of means of generation	
	c)	Means to provide automatic disconnection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values	
	d)	Means to prevent connection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values	
	e)	Means to isolate generator from the public supply system	
2.3	Presence of alternative / additional supply warning notices at:		
	a)	The origin	
	b)	The meter position, if remote from the origin	
	c)	The consumer unit / distribution board to which the alternative / additional sources are connected	
	d)	All points of isolation of ALL sources of supply	
3.0	**AUTOMATIC DISCONNECTION OF SUPPLY**		
3.1	Presence and adequacy of protective earthing / bonding arrangements as follows:		
	a)	Distributor's earthing arrangement	
	b)	Installation earth electrode (where applicable)	
	c)	Earthing conductor and connections	
	d)	Main protective bonding conductors and connections	
	e)	Earthing / bonding labels at all appropriate locations	
	f)	RCD(s) provided for fault protection	
3.2	Accessibility of:		
	a)	Earthing conductor connections	
	b)	All protective bonding conductors	
3.3	FELV – requirements satisfied		
3.4	Reduced low voltage – requirements satisfied		
4.0	**BASIC PROTECTION**		
4.1	Presence and adequacy of protective measures to provide basic protection		
	a)	Insulation of live parts	
	b)	Barriers or enclosures	

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SCHEDULES OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)				
	c)	Obstacles*		
	d)	Placing out of reach*		
5.0	**ADDITIONAL PROTECTION**			
5.1	The presence and effectiveness of additional protection methods used, as follows:			
	a)	RCDs not exceeding 30 mA operating current		
	b)	Supplementary bonding		
6.0	**OTHER METHODS OF PROTECTION (insert location in box provided)**			
	The presence and effectiveness of other methods of protection against electric shock where used, as follows:			
6.1	Basic and fault protection			**LOCATION**
	a)	SELV		
	b)	PELV		
	c)	Double insulation / Reinforced installation		
	d)	Electrical separation for one item of equipment		
6.2	Fault protection			**LOCATION**
	a)	Non-conducting location / Earth-free local equipotential bonding*		
	b)	Electrical separation for more than one item of equipment*		
7.0	**DISTRIBUTION EQUIPMENT**			
7.1	Adequacy of working space / accessibility			
7.2	Security of fixing			
7.3	Insulation of live parts not damaged during erection			
7.4	Adequacy / security of barriers			
7.5	Suitability of enclosures for IP and fire ratings			
7.6	Enclosures not damaged during installation			
7.7	Presence and effectiveness of obstacles			
7.8	Presence of main switch(es), linked where required			
7.9	Operation of main switch(es) (functional check)			
7.10	Operation of circuit-breakers and RCDs to prove functionality			
7.11	RCD(s) provided for fault protection, where specified			
7.12	RCD(s) provided for protection against fire			
7.13	RCD(s) provided for additional protection, where specified			
7.14	Confirmation overvoltage protection (SPDs) provided where specified			
7.15	Confirmation of indication that SPD is functional			
7.16	Presence of RCD six-monthly test notice where required			
7.17	Presence of AFDD six-monthly test notice where required			
7.18	Presence of diagrams, charts or schedules at or near each switchgear, where required			
7.19	Presence of non-standard (mixed) cable colour warning notice at or near the appropriate distribution board, where required			
7.20	Presence of next inspection recommendation label			
7.21	Presence of other required labelling			
7.22	Selection of protective device(s) and base(s); correct type and rating			
7.23	Single-pole protective devices in line conductor only			
7.24	Protection against mechanical damage where cables enter equipment			

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SCHEDULE OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)			
7.25	Protection against electromagnetic effects where cables enter ferromagnetic enclosures.		
7.26	Confirmation that ALL conductor connections, including connections to busbars are correctly located in terminals and are tight and secure		
8.0	**CIRCUITS**		
8.1	Identification of conductors		
8.2	Cables correctly supported throughout their length		
8.3	Examination of cables for signs of mechanical damage during installation		
8.4	Examination of insulation of live parts, not damaged during erection		
8.5	Non-sheathed cables protected by enclosure in conduit, ducting or trunking		
8.6	Suitability of containment systems (including flexible conduit)		
8.7	Correct temperature rating of cable insulation		
8.8	Adequacy of cables for current-carrying capacity with regard to the type and nature of installation		
8.9	Adequacy of protective devices: type and rated current for fault protection		
8.10	Presence and adequacy of circuit protective conductors		
8.11	Coordination between conductors and overload protective devices		
8.12	Wiring systems and cable installation methods / practices appropriate to the type and nature of installation and external influences		
8.13	Cables installed under floors, above ceilings, in walls / partitions, adequately protected against damage		
	a)	Installed in prescribed zones	
	b)	Incorporating earthed armour or sheath, or installed within earthed wiring system, or otherwise protected against mechanical damage by nails, screws and the like	
8.14	Provision of additional protection by RCDs having a rated residual operating current (IΔn) not exceeding 30mA:		
	a)	For mobile equipment with a current rating not exceeding 32 A for use outdoors	
	b)	For all socket-outlets of rating 32 A or less, unless exempt	
	c)	For cables installed walls / partitions at a depth of less than 50mm	
	d)	For cables installed in walls / partitions containing metal parts regardless of depth	
	e)	Final circuits supplying luminaires within (domestic) household premises	
8.15	Provision of fire barriers, sealing arrangements so as to minimize the spread of fire		
8.16	Band II cables segregated / separated from Band I circuits		
8.17	Cables segregated / separated from non-electrical services		
8.18	Termination of cables at enclosures		
	a)	Connection under no undue strain	
	b)	No basic insulation of a conductor visible outside enclosure	
	c)	Connections of live conductors adequately enclosed.	
	d)	Adequately connected at point of entry to enclosure (glands, bushes etc.)	
8.19	Suitability of circuit accessories for external influences		
8.20	Circuit accessories not damaged during erection		
8.21	Single-pole devices for switching in the line conductor only		
8.22	Adequacy of connections, including cpcs, within accessories and at fixed and stationary equipment		
9.1	Isolators		
	a)	Presence and location of appropriate devices	
	b)	Capable of being secured in the OFF position	
	c)	Correct operation verified (functional check)	

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SCHEDULES OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)			
	d)	The installation, circuit or part thereof that will be isolated is clearly identified by location and / or durable marking	
	e)	Warning label posted in situations where live parts cannot be isolated be isolated by the operation of a single device.	
9.2	Switching off for mechanical maintenance		
	a)	Presence of appropriate devices	
	b)	Acceptable location (state if local or remote)	
	c)	Capable of being secured in the OFF position	
	d)	Correct operation verified (functional check)	
	e)	The circuit or part thereof to be disconnected clearly identified by location and / or durable marking	
9.3	Emergency switching / stopping		
	a)	Presence of appropriate devices	
	b)	Readily accessible for operation where danger might occur	
	c)	Correct operation verified (functional check)	
	d)	The installation, circuit or part thereof to be disconnected, clearly identified by location and / or marking	
9.4	Functional switching		
	a)	Presence of appropriate devices	
	b)	Correct operation verified (functional check)	
10.0	**CURRENT USING EQUIPMENT (PERMANENTLY CONNECTED)**		
10.1	Suitability of equipment in terms of IP and fire ratings		
10.2	Enclosure not damaged / deteriorated during installation so as to impair safety		
10.3	Suitability for the environment and external influences		
10.4	Security of fixing		
10.5	Cable entry holes in ceilings above luminaires, sized or sealed so as to restrict the spread of fire		
10.6	Recessed luminaires (downlighters)		
	a)	Correct type of lamps fitted.	
	b)	Installed to minimise build-up of heat.	
10.7	Provision of under voltage protection, where specified		
10.8	Provision of overload protection, where specified		
10.9	Adequacy of working space / accessibility to equipment		
11.0	**SPECIAL INSTALLATIONS OR LOCATIONS**		
List below any Special Installations or Locations which are part of the installation to be verified, and confirm that the additional requirements given in the respective section of Part 7 are fulfilled.			

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SCHEDULES OF INSPECTIONS (FOR INITIAL INSPECTION AND TESTING)	
11.0 OTHER	
List below any electrical installation works not covered in the above checklist that has been inspected and verified.	

* For use in controlled supervised / conditions only.

NOTES

1) All entry boxes on the schedules must be completed.

2) '✓' indicates that an inspection was undertaken and the result was satisfactory.

3) 'N/A' indicates that an inspection was not applicable to the installation.

The above checklist need not be completed where all of the inspection items above are included on the 'Schedules of Items Inspected' schedules, which form part of the certification provided by Electrical Contracting Certification Schemes.

Section Four

Energy Metering

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4-1 GENERAL REQUIREMENTS

The energy metering systems required for this project shall be designed, installed and commissioned to allow the client to measure utility and energy use in the building.

It is essential to the successful operation that the meters and meter reading system be procured from the same single source.

The energy metering system shall be provided as part of the building management system.

The energy metering system shall be fully compliant with all relevant Regulations and Standards as listed below in 'Standards Applicable'.

4-2 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS			
BCO	Building Control Officer	HWSR	Hot Water Service Return
BCWS	Boosted Cold Water Service	LTHW	Low Temperature Hot Water
BMS	Building Management System	MCWS	Mains Cold Water Service
COW	Clerk Of Works	NDBSCG	Non Domestic Building Services Compliance Guide
CV	Check Valve	O&M	Operation and Maintenance Manual
DEC	Displayed Energy Certificate	RDS	Room Data Sheets
DRV	Double Regulating Valve	TMV	Thermostatic Mixing Valve
EPC	Energy Performance Certificate	VAV	Variable Air Volume
Engineer	Engineer representative from Couch Perry & Wilkes LLP	VFC	Volt Free Contacts
HWSF	Hot Water Service Flow	WRAS	Water Regulation Advisory Scheme

4-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred materials and standard or utilise one of the alternative materials and standards of construction listed in the 'General Installation Standards' sections detailed earlier in this specification. Agreed alternative materials for the installation from the preferred standard material and standard of construction are:

No deviation from the 'General Installation Standards' section preferred material and jointing method requirements.

'General Installation Standards' Sections provides all necessary details on pipework and valve materials and performance requirements that apply to this section.

4-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BSRIA Commissioning Codes	Building Regulations, particularly Part L2
CIBSE Commissioning Codes	CIBSE CP1 – Heat Networks Code of Practice
CIBSE Guide H – Control Systems	CIBSE TM39 – Building Energy Metering
Heat Network (Metering and Billing) Regulations	Pressure Equipment Regulations & amendments

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

4-5 SCOPE OF WORKS

The following brief description lists the requirement for the energy metering system on this project. System requirements are detailed in this specification together with schematic and design drawings.

The energy metering installation shall include for all necessary tools, labour, materials and equipment to design, supply, install, commission and put into operation the energy metering system to meet the following requirements:

1) Fully comply with Part L2 of the Building Regulations.
2) Fully comply with recommendations detailed in CIBSE TM39.

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3) Be provided as part of the Building Management System.
4) Electrical metering.
5) Water flow meters to the domestic cold water services.
6) Heat meters to the heating services.
7) Liaison with other trades on site.
8) Copies of Operating and Maintenance instruction manuals including a 'brief description' of services and fault finding information list of spares, emergency telephone Nos. etc.
9) Full user instruction, both written and in the form of demonstrations.
10) Provide all necessary information for inclusion in the Building Log Book.
11) Complete electrical installation works associated with this Section of the Specification including all cabling, local isolation and protective devices.
12) Development of the Consultants drawings and detailing from the base tender information to full construction standards as detailed previously. This shall include responsibility for the following areas:-
    a) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.
    b) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents.
    c) Development of the controls specification for the hardware, software, power, controls wiring and all associated equipment.

4-6 PARTICULAR REQUIREMENTS

The energy metering system shall be provided by the Building Management System specialist and shall be fully integrated into the Building Management System.

The tender drawings and schematics show the main energy meters that are believed to be needed for the project however the energy metering specialist shall be responsible for assessing and providing all necessary meters for a fully compliant design based on the completed systems design. All costs associated with providing all necessary meters and associated works shall be included at tender.

4-7 INCOMING SERVICES METERING

Flow meters shall be provided where services enter the building, these shall be provided irrespective of whether separate meters are also being provided by the utility companies for their billing purposes. These client owned flow meters are required to provide overall water use by the project to allow the client to:

1) Review the accuracy of the utility company or other charged utility use.
2) Review the total energy used by all their sub-meters to quickly determine if the total of all sub-meters matches the main meters.

These meters shall be installed above ground at the entry point into the building.

4-8 SUB-METERING

The energy monitoring system shall be fully in accordance with the following specific requirements. The meters shall be linked back to the energy monitoring head end.

All new meters shall be monitored and logged at intervals agreed with the client. For tender allow for meter readings to be logged and collated every 10 minutes and sufficient system capacity to store meter readings.

The selection of the correct type of water and energy meters and ancillary equipment is important to ensure all gas and water use is monitored, inappropriate meter selections may result in some of the water and energy usage may not be monitored. The specific type of meter selected will depend on:

- Minimum and Maximum Flow. It is imperative the meter is capable of reading from minimum to maximum flow.
- Turndown Ratio.

All meters shall be certified as MID approved for commercial and industrial billing purposes.

All meters shall be provided by the Mechanical Contractor except for the meters within the main electrical LV panel and distribution board meters.

Energy meters shall be manufactured by the following and installed fully in accordance with the manufacturer's recommendations:

HEAT METERS	
MANUFACTURER	MODEL
Kamstrup	Multical 603 and 803 (The 803 particularly for environments that are or could be subject to dust, and humidity) with Ultraflow sensors and integral loggers
Itron	CF Echo II with integral calculator
Siemens	Sitrans MAG5100 series and appropriate transmitter

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WATER METERS	
MANUFACTURER	MODEL
Siemens	MAG5100 series or similar and appropriate transmitter, especially where there is a risk of fouling
Itron	Woltex M MID Version with integral reading and output
Itron	Aquadis+ (residential type use)
Senus	accuMAG with integral metering

ELECTRICAL METERS	
MANUFACTURER	MODEL
Provided by the Low Voltage (LV) panel manufacturer.	All electrical meters shall be fully compatible with the energy metering system.

4-9 SOFTWARE AND PROGRAMMING

The energy monitoring system shall be provided with all necessary software and software licences for a fully complete and operational system.

The Specialist Contractor shall allow for all necessary programming to calibrate all actual readings with the software and include for a logical easy to understand and interrogate graphical interface on the BMS system.

4-10 METERING COMMISSIONING AND HANDOVER

For all flow meter installed into pipe work to maintain meter accuracy, the meter manufacturer's minimum number of straight pipe diameters of unrestricted pipe lengths before, and after, the meter to provide LAMINAR flow through the meter must be adhered to.

To comply with Health and Safety along with CDM all meter reads outs are to be installed in easily accessible positions to enable the operator to read the meter face to minimise the risk of working at height or back strain etc. To eliminate the risk, a suitable, permanent access platform may be required in exceptional circumstances for maintenance.

The entire energy metering systems shall be fully commissioned fully in accordance with both CIBSE TM 39 and the energy metering system supplier.

Section Five

Enabling and Incoming Services Works

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5-1 GENERAL

This section of the specification identifies the enabling work required for this project as below:-

1) Provision and installation of new mains cold water service from the statutory authority supply
2) Provision and installation of Fire Hydrant Main

5-2 DEFINITIONS

Refer to Preliminary Section for general definitions plus below:

DEFINITIONS	
MCWS	Mains Cold Water Service
LTHW	Low Temperature Hot Water
DNO	Distribution Network Operator

5-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with particular sections, commissioning and standard clauses, all of which define further the requirements for this project.

5-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
Current Building Regulations	Water Regulation Advisor Scheme (WRAS)
CIBSE Guides	BS 1710 – Pipework identification
All CIBSE & BSRIA Commissioning Codes	BS-EN 13792 – Colour Codes
National Joint Utilities Group Guidelines (NJUG)	BS 7671 – Wiring Regulations
Water Industry Specifications including WIS 4-08-01 & WIS 4-08-02	BS EN 12201 – PE 80 pipework (Water)
Institute of Gas Engineers and Managers publications (IGEM)	BS EN 1555 – PE 80 pipework (Gas)
Health and Safety Executive Approved Code of Practice L8 Control of Legionella Bacteria in Water Systems	BS EN 9990 – Non Automatic Fire Fighting Systems
BS 3251 Indicator plates for fire hydrants	BS EN 5041 – Hydrant Systems
BS EN 14339 Underground Fire Hydrants	BS EN 14384 Pillar Hydrants

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

5-5 SCOPE OF WORKS

The following brief description describes the enabling works required for this project. Comprehensive system(s) requirements are detailed in subsequent clauses of this specification and on tender schematic and drawings. The Contractor shall employ Specialist Contractor(s) for each of the system(s) and shall include for all tools, labour, materials and equipment necessary to undertake all installation works as below inclusive of:

1) Provide new statutory authority water supply to site and extend distribution to building. Allow for all liaison with supply authorities.
2) Provide new statutory authority fire main and hydrant supply to site and extend distribution to building. Allow for all liaison with supply authorities.
3) Diversion or lowering of any gas, water or fire mains services for the creation of the new site entrance.
4) Carry out a Subtronic survey to establish any below ground services on the site.

5-6 DRAWING INFORMATION

1) Existing record drawings are included within the tender package for information only The Contractor shall also allow to carry out a full subtronic survey of the site to verify the information contained and / or identify further services.

5-7 EXTERNAL SERVICES

The following new supplies shall be provided to serve the building:

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5-7-1 MAINS COLD WATER SUPPLY

1) A MCWS shall be provided to the site from the existing statutory service within the road (Crookthorn Lane) adjacent to the site boundary. The Contractor shall allow for liaison with the Statutory Authority to provide and install the new supply and meter on the boundary of the site. Provide all the external MCWS pipework from the meter to the building incoming position which shall be fully installed, tested and commissioned. For details of internal requirements refer to Domestic Water Services Section of this specification.

5-7-1-1 SOIL ANALYSIS

At this stage in the project it shall be assumed that the ground is contaminated and therefore Protecta-Line pipework shall be utilised for the external services and not standard MDPE pipework. The requirements of the installed systems shall be further developed during detailed design by the Contractor.

The Contractor shall also make reference to installation clauses of the specification.

5-7-1-2 MAINS COLD WATER PIPEWORK

External below ground pipework shall be:

PROTECTA-LINE POLYETHYLENE WATER MAINS (CONTAMINATED GROUND)

Should the soil analysis reports determine that contaminants do exist within the ground, the pipework installed within the service trench shall be:

1) A three layer composite pipe consisting of internal standard PE pipe for the conveyance of water, aluminum layer to prevent the ingress of contaminants and an external polyethylene protective layer.
2) All fittings, flanges and valves, necessary to complete the installation shall be suitable for this composite pipe installation and Electro-fuse fittings.
3) The installation shall be Electro fused utilising the manufacturers recommended procedures and fusion equipment. Underground joints and pipe exposed by peeling the protective layer shall be wrapped with Protecta-line tape in accordance with the manufacturer's instructions.
4) All pipework shall be installed in a neat workmanlike manner and adequately restricted with suitable anchor points and backfill.
5) At this stage in the project it shall be assumed that the ground is contaminated and therefore Protecta-Line pipework shall be utilised for the external services. The requirements of the installed systems shall be further developed during detailed design by the Contractor

Manufactured by:

- GPS PE Pipe Systems Tel No 01480-442600
- Or equal and approved

Trenching requirements:

1) The external trench is excavated having a level base so that the pipework can be laid flat. The trench depth shall provide a minimum cover of 1000 mm to the crown of the water pipework.
2) A 150mm deep bedding of sand or pea gravel shall be laid under the barrel of the pipe. The bedding should be properly compacted to provide uniformity of support to the pipe.
3) After the pipes have been laid, further bedding material shall be placed around the pipe and compacted in 75mm layers up to a level of 150mm above the top of the pipe.
4) To assist the future location/tracing of plastic pipe an approved metallic marker tape shall be laid along the line of main and connected at each end to a hydrant. The marker tape shall be 150mm above pipe.
5) The entry positions to the building are correctly positioned.
6) All underground valves are housed within proprietary valve chambers.
7) Liaison with the local Water Company, Fire Advisor and Drainage Contractors.

5-7-2 FIRE HYDRANT

A fire hydrant ring main shall be provided for the site. The water supply to the hydrants shall be direct from the statutory mains cold water supply via separate unmetered connections and be provided with isolation valves and suitable back flow prevention device at each supply connection point. Additional isolation valves shall be provided to allow for maintenance of the ring main.

Fire hydrants of the below ground type shall to be provided in the positions indicated on the drawing and to the detail shown on the drawing. The system and components shall be installed and tested in compliance with the current British Standards.

The Contractor shall liaise with the local Fire authority/Fire Advisor and all fire hydrants shall be of the types approved by the local Fire Authority.

Hydrants shall be sited:

1) Not more than 90m from any building entrance
2) Not more than 90m apart
3) With a minimum clearance from building of 6m
4) Shall be installed adjacent to roadways and/or hard standing, in suitable positions for Fire authority access

Hydrants shall be complete as follows:

1) Shell manufactured in ductile iron with epoxy coating.
2) Suitable for PN25 pressure
3) All seals WRAS approved

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4) Suitably sized outlet valve

5) Complete with CE Marking and certification.

6) All hydrants shall be provided with an identification plate.

Underground Hydrants

The underground hydrants shall be installed within a brick build chamber with cover and concrete base (refer to drawing details)

The outlet shall be a maximum of 300mm below ground. The unit shall incorporate a frost valve.

5-7-3 TESTING OF UNDERGROUND PIPELINES

The mains to be tested shall be inspected for compliance with the drawings and specifications significant variations shall be investigated and corrected, where required, before proceeding with the test.

After laying, jointing and anchoring the pipeline shall be tested as described in Standard Installation Section of this specification.

Pressure testing shall be carried out prior to any backfilling of trenches. All new pipework is to be tested before being brought into service.

The pipeline shall be subjected to a site test for the purpose of checking of the following: -

1) Mechanical soundness and leak tightness of pipes and fittings.

2) Leak tightness of joints.

3) Soundness of construction anchorages.

4) Quality of installation and workmanship.

It is recommended that hydraulic test pressures applied to ductile iron pipelines are in accordance with those specified in BS 8010 Part 2 'Code of Practice for Design, Construction and Installation of Pipelines on Land'.

For the Protecta-line pipe careful hydrostatic testing of polyethylene mains shall be adopted and must be limited to 1.5 times the rated pressure and reduced accordingly if the test temperature exceeds 20°C.

Testing procedure shall be in accordance with the manufacturer's instructions.

It must be established before tests commence that all anchorages are in position, that concrete anchorages have developed the required strength and that where pipes are deflected to produce large radius curves, the backfill between pipe body and trench wall is well compacted.

Final test of pipelines shall be completed in one length. Sectional testing shall be for the benefit of the Contractor and shall not be considered as final tests.

Where interim section testing is to be performed, special stop ends shall be provided for the safe introduction and disposal of test medium and release of air. The stop ends shall be secured by adequate temporary anchors.

5-7-3-1 CHLORINATION AND WATER SAMPLES

Water samples shall be taken before undertaken modifications to the water mains and upon successful testing of the modified new water main.

All new pipework shall be fully chlorinated from suitable points of demarcation (isolating valve sets etc.) conforming to the requirements of Standard Installation Section of this specification, with water samples taken and tested in accordance with the guidelines of 'Analysis of Raw, Potable and Waste Waters', published by D of E, HMSO and/or methods approved and employed by the Public Health Authority.

5-7-3-2 UNDERGROUND PIPEWORK

The system shall be installed in pre-insulated pipes and shall be a bonded system according to EN 13941 and other EN standards mentioned in this specification or by the Manufacturer. The bonded system takes its name from the fact that the steel carrier pipe, (polyurethane foam) and jacket pipe are bonded together.

The outer surface of the carrier pipe and the inner surface of the jacket pipe are pre-treated to ensure that the foam adheres to the pipes, and that forces can be transmitted outwards through the foam.

Both elements of the bonded pipes are designed to expand and move together. Movement is restricted by the friction between the soil and jacket pipe. Expansion shall be absorbed in compensators, relievers and elbows. If an elbow is to be installed for the purpose of absorbing, expansion foam pads shall be incorporated.

Pipe laying methods shall be a Cold Laying method, where expansion during heating shall be absorbed as stresses in the steel-pipes and movements of the pipes in the trench.

The pipe insulation shall be Logstor's "Series 1" pipe or equal and approved.

The movement of the relievers, if used, is to be limited to 20mm.

Joints shall be double sealed and kept to an absolute minimum.

The pre-insulated pipes shall include a leak detection system for the detection of moisture in the insulation complete with integral controls monitoring to report to BMS system for fault.

Valves

Below ground valves shall be installed within chambers. The valves shall be pre-insulated, stainless steel ball valve with spring loaded Teflon seats and a fully welded casing to ensure a completely watertight installation. Valves shall be complete with extended spindle for ease of access.

All pipework and valves shall be provided by one of the following manufacturers:-

1) Logstor

2) PPSL District Energy.

3) Pipe 2000

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Section Six

Design Standards

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6-1 GENERAL REQUIREMENTS

All the Mechanical and Electrical Services are being tendered on a performance basis for this project. The Contractor shall be responsible for the full adoption of the design concepts and principles provided, detailed design, installation and commissioning of all necessary building services to suit the building layouts and passive fabric principles. This section of the Performance Specification details the design standards that shall be adhered to in the development of the design of the building services, including all passive measures set out by the Client's team for the project. This section should not be taken as being exhaustive, but it is indicative of the quality and standards required for the project.

Note that the drawings issued with the tender are to illustrate the design concepts and principles to be fully adopted and developed into a fully detailed design at the start of the contract period prior to any services being installed on site.

CIBSE TM59 MANDATORY FINAL DESIGN REQUIREMENTS

All residences shall fully comply with the recommendations of CIBSE TM59. All modelling and reports shall be provided as part of the design of this project to prove that the residences do not overheat.

All costs associated with this fundamental requirement shall be included for at tender.

The design requirements for this project are listed below and summarised in the following clauses:

1) Building Control Officer's requirements.
2) All Building Regulations compliance.
3) Energy Performance Certificate.
4) Compliance with Part L of the Building Regulations current at the time of tender and declared start on site date.
5) Thermal & Energy Modelling to achieve and then prove EPC compliance.
6) CIBSE TM52/TM59 overheating assessment, report and compliance.
7) Compliance with BS 7671 IET Wiring Regulations – Requirements for Electrical Installations, all supporting IET documentation and all British Standards / Statutory Regulations referenced within these documents.

Where discrepancies are found between this specification, relevant standards, room data sheets, drawings, Employer's documentation, Architect's documentation, Structural documentation and Quantity Surveyor's documentation, the tenderer shall allow for the costs associated with the most onerous condition within their returned tender, should the return tender period permit, obtain written clarification regarding any discrepancies from the Engineer.

Where discrepancies have not been clarified prior to the submission of the tender return it shall be assumed that the most onerous condition has been allowed for and no tender qualifications shall be permitted against this item.

6-1-1 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS			
AHU	Air Handling Unit	HWSR	Hot Water Service Return
BCO	Building Control Officer	MCWS	Mains Cold Water Service
BCWS	Boosted Cold Water Service	NDBSCG	Non-Domestic Building Services Compliance Guide
BREEAM	Building Research Establishment Environment Assessment Method	O&M	Operation and Maintenance Manual
COW	Clerk Of Works	PHX / PHE	Plate Heat Exchangers
CV	Constant Volume	RAC	Run Around Coil Heat Exchanger
DEC	Displayed Energy Certificate	RDS	Room Data Sheets
DRV	Double Regulating Valve	TCV	Thermal Circulation Valve
DX	Direct Expansion (refrigerant system)	TMV	Thermostatic Mixing Valve
EPC	Energy Performance Certificate	VAV	Variable Air Volume
Engineer	Engineer representative from Couch Perry & Wilkes LLP	VCD	Volume Control Damper
ESP	External Static Pressure	VFC	Volt Free Contacts
HWSF	Hot Water Service Flow	WRAS	Water Regulation Advisory Scheme

Reference shall also be made to Section 2E of this specification and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

6-1-2 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the rest of this specification, all of which define further the requirements for the overall installation.

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6-1-3 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS (INCLUDING ALL AMENDMENTS)	
ANSI / TIA / EIA Telecommunications Standards	British Standards (BS)
BS EN Euro Codes	BESA (HVCA) Guides
Building Research Establishment (BRE) Good Practice Design Documents	Building's Insurance Requirements
Building Regulations and Second Tier Documents	Specific requirements of local Environment Health Officer, Fire Advisor and Building Control Officer.
Building Research Establishment Documents	BSRIA Good Practice Design and technical documents
Thermostatic Mixing Valve Manufacturers Association Recommended Code of Practice for Safe Water Temperatures'	Chartered Institute of Building Services Engineers (CIBSE) Design Guides, Knowledge Series, Application Manuals and Technical Memoranda
Client Design Standards AND Room Data Sheets	Client Insurance Company's requirements
Construction Products Regulations	Construction (Design and Management) Regulations (CDM)
Control Of Substances Hazardous to Health (COSHH)	Clean Air Act
Energy Networks Association (ENA) / ESI publications	Energy Related Products (ErP) compliance
Factories Act	Fire Industry Association (FIA) Publications
Health and Safety Executive (HSE) Approved Codes of Practice and Guidance	Health and Safety at Work Act
Equality Act	Institute of Gas Engineers and Managers (IGEM) Utilisation Procedures
National Joint Utilities Group Publications (NJUG)	National Security Inspectorate (NSI) Publications
Pressure Equipment Regulations	Water Regulations

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

6-1-4 COMPLIANCE WITH PART L OF BUILDING REGULATIONS

The Main Contractor shall be ultimately responsible for achieving compliance with all Building Regulation requirements and shall undertake all necessary coordination and liaison to facilitate this. However, unless otherwise agreed, the Mechanical Contractor shall be responsible for taking the lead role in achieving full compliance with current Part L2 of the Building Regulations, this shall include:

1) Initial meetings to agree the final fabric performance and building air tightness with the design team that shall be equal or better to those stated within this specification to meet project performance requirements given.
2) Production of dynamic Thermal, Energy and Carbon Part L model utilising level 5 accredited IES Virtual Environment software.
3) Review / development of model with design team to achieve compliant scheme with a margin to ensure that compliance can still be achieved at completion. Margin required to ensure compliance should the design and installation change from initial detailed design to completion.
4) Produce summertime 'operative' (as defined in CIBSE) temperature reports for every room and space using thermal modelling. Thermal model to demonstrate compliance with summertime 'operative' temperatures i.e. as listed elsewhere in this section / maximum 28°C is not exceeded by more than 1% of occupied time.
5) Full Part L2 compliance is mandatory on completion irrespective of any installation and construction issues. All measures required to comply with the current Part L2 Building Regulations shall be deemed to be included within the tender.
6) Produce a report for issue to Building Control covering all current Part L2 criteria.
7) Meet with Building Control to present and agree report, providing clarification as necessary.
8) Provide advice to the design and employer's teams on any changes through the contract period where these will impact upon the building with regard to Part L compliance, any compromises with one element must be negated by improvements elsewhere within the overall design such that the building as a whole remains fully compliant.
9) Update model and report to incorporate as constructed details and test results and submit to Building Control at completion.
10) Provide an Energy Performance Certificate (EPC), and recommendation report for the building to the Client, issued via the Main Contractor, and the Building Control Body with notice to that effect.

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11) The person responsible for conducting the energy assessment and producing the EPC must be an accredited Energy Assessor qualified for the level of building being assessed and listed on the national register at www.ndepcregister.com and a member of an Accreditation Scheme approved by Department of Communities and Local Government (CLG).

12) Fully liaise with all members of the design team and provide details of what technical input is required from each party, including time allowances for meetings/development, technical details and design development to fully complete the L2 and EPC calculations.

13) The updated legislation places more impetus on providing lower delivered energy consumption and reduced building CO2 emission rates in accord with the Government commitment to satisfy the European Energy Performance of Buildings Directive.

14) Ensure that the relevant electrical services are designed, installed and commissioned to comply with current Part L2.

15) The performance of the building, as built, shall be consistent with the prediction made in the design Target Emissions Rating (TER).

16) A final calculation of the Building Emission Rating shall be provided to reflect any changes in performance between design and construction, and the achieved / measured air permeability, ductwork leakage, and commissioned fan performance etc. The final calculation shall demonstrate that the building 'as constructed' remains compliant and consistent with the predicted design building energy rating. Any works required to bring the building back into compliance shall be completed at no additional cost to the Employer.

17) Produce, and include within the building log book, a notice confirming that all fixed building services have been properly commissioned. The notice shall include a declaration signed by a suitably qualified person, confirming that:

    a) A commissioning plan has been followed such that each system has been inspected and commissioned to a satisfactory standard.

    b) The results of the commissioning tests confirm that the performance is in accordance with the proposed design.

    The notice should be signed a member of either the Membership of the Commissioning Specialists Association or the Commissioning Group of the HVCA.

    Provide a concise building log book in accordance with this specification and current at handover version of CIBSE TM31.

    The building log book shall be provided in addition / as a separate document to, the Building Manual / Operating and Maintenance Manuals.

The following provides a summary of some salient compliance criteria and sets out minimum performance requirements for the same for development by the Mechanical Contractor as part of the Design and Build Team via detailed design, installation and commissioning of the works should better performance be required to achieve the primary energy and carbon emissions performance then those shall be included with the Main Contractor's tender:

1) The predicted rate of energy and CO_2 emissions from the building shall not be greater than the agreed value set out within the planning submission report and to the standards given in this specification, when determined in accordance with the procedure set out within Approved Document Part L2.

   The following values provide an indication of the requirements needed to comply with this criterion and also set out minimum performance parameters for the design of the building and the engineering systems agreed with the Project Team to promote operational efficiency.

   - Overall Building Air Permeability - $3m^3/hr/m^2$ at 50Pa – Positive and Negative test trends required.
   - Fabric U-Values :
     - Glazing and doors (installed, including frame) - 1.1 W/m^2K
     - External walls - 0.15 W/m^2K
     - Ground floor - 0.17 W/m^2K
     - Exposed roof - 0.17 W/m^2K
   - Glazing Solar Spec - G-Value <=0.33, Ltr-Value >=0.7
   - Thermal Bridges - DCLG accredited robust details for (PSI) 0.03 W/mK or better
   - Cooling seasonal efficiency ESEER - Refer to the cooling section.
   - EER – Energy Efficiency Ratio - Refer to the cooling section.
   - Lighting:
     a) Refer to electrical specification.
   - Power factor correction - > 0.95
   - Energy monitoring with monitoring and alarms for out of normal range values to all systems.
   - Ventilation Max specific fan power: Refer to ventilation section for details.
   - Low and Zero Carbon description.

2) The performance of the building fabric and the heating, hot water and fixed lighting systems shall be no worse than the minimum design limits of current Approved Document L2 and that referred above.

3) Those parts of the building that are not provided with comfort cooling systems shall have appropriate passive control measures to limit solar gain.

6-1-5 DOMESTIC PROJECTS OVERHEATING ASSESSMENTS

The residences shall be fully assessed fully in accordance with CIBSE TM 59 to prove that the final projects do not overheat. The methodology is fully defined in CIBSE TM 59 and all thermal modelling, reports and necessary remedial or re-design works shall be included for.

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6-1-6 THERMAL / ENERGY MODELLING

Provide a detailed thermal / energy model using the latest version of the IES Limited VE accredited software package and certified and accredited software modeller.

The outline typical model used during the initial stages of the concept design by the employer's team shall be available via the software specialist (IES Ltd) to assist in developing tender and contractual requirement for compliance model for the project. The following procedure shall be adopted:

1) An outline model report developed for current Part L2 CO_2 and summertime analysis has been provided by the Engineer as part of the tender documentation, this Part L model is for guidance only.
2) The outline model provided has been generated by the engineer and verified by IES Ltd (software provider). The IES Ltd engineer shall be employed to undertake any adjustments required to the model to demonstrate that the requirements of Part L2 are met. Upon completion of any design development adjustments it is the responsibility of the tenderer to employ IES Ltd to provide a detailed model service. The final checked electronic model shall be submitted to the whole design team for comment. Upon completion of the verification, tenderer shall provide a BRUKL document, along with an EPC for the building that demonstrates compliancy with this specification.
3) Ensure any changes made to the model are verified by IES Ltd and the designer and then provided to the Engineer for comment.
4) Full ownership of the model completing any checks / validation they deem necessary to allow them to take full responsibility for the model shall be included within the tender return.

The IES Level 5 model shall:

1) Be an accurate representation of the building form and structure including all material thermal and solar performance properties.
2) Include local shading such as adjacent buildings, obstructions and trees etc.
3) Include actual occupancy profiles as detailed in the performance specification, Room Data Sheets (RDS) or agreed with the Client / Engineer.
4) Include actual lighting installation including actual power, efficacy, switching / dimming control etc.
5) Occupancy, small power and lighting gains shall not be considered for beneficial heat gains as the equipment and lighting will not be operational when the rooms are initially occupied at the start of occupancy when the rooms shall be required to already be at the design operative temperatures.
6) Include all process power loads and energy gains.
7) Diversity of the systems shall be conservatively assessed and only included in the model where they have been agreed in writing with the Engineer.
8) Any renewable systems shall be included, with any benefit assessed conservatively based on actual site conditions / systems and manufacturers lowest predicted performance. No benefit shall be taken for importing from the grid on green or renewable tariffs.
9) The thermal model shall be tested with the current CIBSE .DSY file weather file for the most suitable region for the project.

The small power loads used within the model shall be assessed based on furniture layouts and room data sheets. Loads less than those scheduled below shall not be adopted unless agreed in writing with the Engineer:

SMALL POWER & GENERAL LOADS	
DESCRIPTION	ALLOWANCE
Standard PCs c/w Flat Screen	90W
Laptops	36W
Printers (small commercial type in typical office)	135W
Photocopiers (small commercial type in typical office)	500W
Projectors	200W
Audio Visual Equipment	4,000W
General Office Areas	Preference shall always be to base IT loads based on Room Data Sheets, where these are not provided allow the following: • IT equipment shall be based upon furniture layout with one standard PC per person based on the number of seats plus 1 small commercial type printer per cellular room or per 10 occupants in open plan offices. • Photocopiers shall be provided as indicated in dedicated zones and if not indicated allow photocopier heat gains for tender based on one photocopier per 50 persons.
Standard fridge (A++ Rated)	150W
Standard freezer (A++ Rated)	300W
Communication and Server Rooms	To be calculated in accordance with IT requirements (For tender assume 2kW per wiring cabinet in communication rooms and 8kW per cabinet in server rooms)
People (Based on activity)	Refer to CIBSE Guide A Table 6.3 (in Appendix of Section 6)
General office lighting, where actual value not known.	10 W/m²

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SMALL POWER & GENERAL LOADS	
DESCRIPTION	CONDITION
Generic benchmark heat gains, that is W/m^2, shall not be used for equipment and occupancy gains unless adequate information is not available and these are agreed to be used in writing by the Engineer.	

A detailed report shall be produced and submitted to the Engineer for comment to include:

1) Schedule of all materials and their thermal and / or solar properties.
2) Schedule of all profiles used.
3) Schedule of all heat gains and occupancies per room.
4) Schedule of services plant, equipment and lighting systems, their efficiencies, controls, and operating times etc.
5) Hours report detailing number of hours and percentage of occupied time that the Research and Production Laboratories
6) Schedule of all improvements made as a result of the modelling process in order to achieve a compliant building. All improvements to meet the criteria shall deemed to be included in the tender.
7) Estimated primary energy consumption and CO_2 emissions broken down by service and end use in GJ, kWh and kgCO_2 with an overall assessment in kWh/m^2, GJ/100m^3 and kgCO_2/m^2 for the following:
   a) Fossil fuels
   b) Grid imported electricity
   c) Renewables (individual) from the thermal and energy model
8) An image of each floor and elevation of the building to demonstrate the same has be configured correctly
9) An isometric image of the building from the four principal directions of view.
10) Details of person whom completed the model including experience and qualifications.
11) Summary of whether the design complies with Part L requirements and proposals if non-compliant.

The report shall be submitted for comment in both electronic (colour PDF) and software export version, this will be subject to the commenting procedure set out for all documents in section one of this specification.

The Mechanical Contractor shall allow for the Part L Overheating models and EPC compliance to be run as many times as required to comply with Employer's Requirements.

Copies of the final design and construction models (electronic IES data and run files) shall be issued to the engineer at each stage described.

6-1-7 INSPECTION OF AIR CONDITIONING SYSTEMS

If the air conditioning installation requires an Inspection as defined under 'The Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations' then on completion of the project this shall be provided by the tenderer.

For details of the specific requirements refer to 'Department for Communities and Local Government' document entitled 'Improving the energy efficiency of our buildings – A guide to air-conditioning inspections for buildings'.

The inspections and report shall be fully in accordance with the recommendations of CIBSE TM44.

A F-Gas Inspection, in accordance with EU Regulation 517/2014, shall also be carried out at contract completion and subsequent repeats and certificate are to be provided to the employer.

6-1-8 PLANNING REQUIREMENTS

The planning requirements for this project are issued as part of the main contract documentation and shall be fully complied with along with supporting information and tests as necessary to fully discharge all conditions that may be affected by (or influenced by) the building services.

6-1-9 ACOUSTICS

The Building Services installation shall be designed to meet the acoustic requirements as given in:

1) Acoustic Design Intent report produced by the Acoustician (available from the Main Contractor).
1) Planning Conditions for external ambient noise reduction.
2) Detailed in the attached room data sheets.
3) Design noise ratings listed in this section of specification.
4) Relevant CIBSE design guides.

Particular attention must be paid to:

1) The design of rotating machinery anti-vibration mountings to ensure noise is not transferred through the structure. Vibration isolation shall be provided to limit noise levels to those given and required by the user equipment within the building.
2) Air borne noise from all ventilation systems shall be carefully limited to meet the low noise levels required by this type of project.
3) The design of fan units to limit noise breakouts from both fan boxes and ductwork components prior to any attenuation. Breakouts shall be limited to ensure noise levels do not exceed levels detailed elsewhere in this brief.
4) The strict requirements for eliminating cross talk potential in various locations.
5) Externally located plant shall be subject to the requirements of the acoustic report/specification, the Planning Authority and the Client and these requirements shall be incorporated into the overall design by Mechanical and Electrical Contractors. The external plant and other existing plant from existing buildings shall not contribute to internal noise levels. Acoustic enclosures and attenuation shall be provided to all the external plant to comply with the acoustic criteria.

Acoustic treatment to building fabric and all services shall be provided to achieve the room specified Noise Ratings.

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Upon Completion of the project and acoustic performance of the scheme shall be measured and verified by an independent Acoustic Consultant.

6-1-10 FIRE PRECAUTIONS

Due allowance shall be made for the inclusion of all necessary fire and smoke dampers, pipe fire collars/sleeves, fire rated ductwork systems and the like where services pass through fire and smoke compartments, cavity barriers, void barriers and floors to maintain full fire and smoke integrity of the barriers.

Ensure all items are included to comply with Building Control, Fire Advisor Report, Client Insurance, Client Fire Advisor and Fire Department requirements.

The provisions for fire detection control and fire extinguishing shall be in accordance with this document, the concept drawings, fire compartment strategy, statutory standards and in addition shall meet any requirements of the local Building Control, local Fire Advisor and Client's Fire Advisor.

The systems shall be designed to provide the following:

1) Fully compliant with all local standards including but not limited to BS 9999.
2) All ductwork systems penetrating fire barriers shall be provided with fire or combined fire and smoke dampers to a specification to meet the requirements of the Building Control and Fire Advisor. All requirements to be agreed with Building Control and Fire Advisor during the detailed design. These dampers shall be either fire or combined fire and smoke dampers controlled via the fire alarm system for the method of evacuation in accordance with the requirements of the Fire Advisor /Building Control Officer and BS 9999.
3) For tender purposes in addition to the fire dampers shall be provided at every 20 metre intervals in the ceiling voids in accordance with the Building Regulations (Part B) ceiling void fire barrier requirements.
4) Should combination fire and smoke dampers be required to meet the project fire strategy and evacuation plan then provide the individual damper and zone control and indication panels in accordance with the clauses contained elsewhere within this Specification. In the event that combination dampers are required the control, monitoring and indication panel(s) shall interface with the fire alarm system to enable control necessary for smoke containment and evacuation as determined necessary. All of this equipment shall be deemed to be included within the tender.
5) All drainage and rainwater pipework that pass through a fire compartment or barrier or floor plate shall be complete with a fire collar. Refer to the above ground drainage section of the Specification for full details.

All services passing through fire compartments shall be fully fire stopped to maintain the integrity of the same.

6-1-11 DESIGN DEVELOPMENT

The tender shall be compliant with information detailed within this Performance Specification, information from the Main Contract and any relevant design guides stated, all of which shall not be taken as being exhaustive, but as indicative of the minimum quality and standards required for the project.

Should any of the tender information be found to be incompatible or ambiguous with other design information, then this shall be raised as a query during the tender period, if no response is provided prior to the tender return date, the tender return shall include for the most onerous option available.

A number of project schematic details and layouts have been incorporated within the Tender, these are provided to demonstrate the design intent only. These drawings shall be developed both during the tender period to inform and complete the tender return and during the detailed design stage to provide a completed design.

Include at tender for the contractual requirements including:

1) Design, installation and commissioning to achieve specified requirements.
2) Lead mechanical and electrical co-ordination role shall be undertaken by the Mechanical Contractor for all mechanical and electrical services except for services installed into the reflected ceiling or suspended from the structural soffit (where not suspended ceiling is proposed), which shall be managed by the Electrical Contractor (due to the importance of the lighting design uniformity, et cetera). Overall co-ordination shall be managed by the Main Contractor, unless agreed otherwise, with the Main Contractor, during the tender period. The party undertaking role of service coordination duties shall be advised at tender return.
3) Production of detailed design drawings, installation drawings, record drawings, builder's work drawings and 'As Fitted' drawings as detailed elsewhere in this Specification.
4) Design of the building services, including mechanical, electrical, plumbing, et cetera and join the Main Contractor's design team consisting of a Main Contractor, Structural Engineer and Architect (and all other design professionals), all with full design responsibility.
5) Detailed design work associated with producing builder's work drawings and all builder's work information associated with the mechanical and electrical installations.
6) Attending all meetings necessary to provide full detailed design and co-ordination of the services with all other trades.
7) Obtain from the Main Contractor, during the tender period, the latest room data sheets for the design and costing processes to ensure that the tender submission is fully compliant with the latest information available.
8) Allow for full co-ordination with the fabric of the building, user ergonomic requirements, structure of the building, existing trees, landscaping etc. and co-ordinating the installation with other trades. Where services routes or similar are shown on the drawings, these are indicative routes only.
9) Assess at tender all plant room sizes, riser sizes, ceiling and floor void depths and service routes ensuring that the Architect and Main Contractor are fully aware of their requirements and accommodate them. All voids, risers and service routes shall offer suitable access in compliance with current CDM requirements and are suitably sized for periodic maintenance to be successfully performed.

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6-1-12 CONTRACTOR DOCUMENTATION PRODUCTION, REVIEWING PROCESS AND DRAWING STATUS DEFINITIONS

The requirements for producing, submitting and reviewing Contractor documentation, including design submissions, are given in Section 1B. Some additional detail regarding the content of design submissions is given in this section.

6-1-13 DESIGN INFORMATION TO BE SUBMITTED BY THE CONTRACTOR

The Contractor shall provide all the necessary design information as outlined in Section 1B of this specification and further amplified in the clauses below.

Examples of plant and equipment for which full sizing details and calculations are required are listed below.

a) Heat emitters
b) Plate heat exchangers
c) Pumps
d) Air handling plant.
e) Air source heat pumps
f) Buffer vessels and thermal stores
g) Fans
h) Motors
i) Water tanks and booster sets
j) Valves
k) Controls interfaces
l) Zone controls
m) Energy metering and metering systems

In addition, provide the following:

- Philosophy drawings to demonstrate detailed design. For example preliminary plant room layouts, pressure cascades, etc.
- Results from latest design packages, such as Hevacomp, IES, TAS, et cetera with sufficient information to demonstrate input data and a summary of results.
- All 2D and 3D drawings.
- Detailed controls (BMS) descriptions in plain, clear and concise English.
- Full technical submissions to the components proposed complete with a specification compliance confirmation.

Provide the following design calculations and schedules for comment, in line with the submission process detailed in section 1B:

1) Sizing and schedules of all equipment/plant and terminal devices
2) Schedule of all heat losses and heat gain calculations for each room or space within the building
3) Pipework system by system sizing
4) Ventilation rates and air trends for each room or space within the building
5) Ventilation system sizing
6) Heating system sizing
7) Cooling system sizing
8) Hot and cold water system(s) sizing
9) Specialist ventilation system(s) sizing
10) Results from thermal and overheating modelling, Energy Modelling and Part L2
11) EPC assessment report and compliance statement
12) Calculations as requested within the Technical Submission sub-sections of all other sections of this specification.

6-1-14 REVIEW OF PLANT AREAS AND SERVICES ACCESS

Review the Architectural proposed drawings, including all other designer proposals, during the tender process to ensure that adequate space is provided for services installations in terms of initial installation, maintenance and future replacement.

Adequate allowances shall be made when locating services to allow easy and safe access for maintenance and inspection, to fully comply with current Health and Safety Regulations and Construction Design and Management (CDM) Regulations.

6-1-15 REVIEW OF SERVICE ZONES

The various zones detailed on the tender drawings are those that have been agreed with the Client and design team as representing the minimum number of zones according to orientation and occupancy profiles, the final design shall review these zones, and if necessary further sub-divide, if determined necessary during the detailed design stage of the project.

Any additional costs incurred for the building services to be contained within the provided service zones shall be included at tender.

6-1-16 LOCATION OF SERVICES

All plant and equipment shall be located in plant rooms and risers provided for this purpose. Services distribution shall be generally concealed in risers, in ceiling voids and floor voids. Exposed services shall be permitted except within plant areas.

Exposed distribution pipework / ductwork / containment shall not be accepted except for where specifically indicated on the Tender drawings or detailed elsewhere in this specification.

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All rooms where services are planned to be exposed under the Architectural Philosophy and as detailed on the tender drawings shall be installed to a high standard and shall be set out in a logical manner to provide an acceptable symmetry.

Mechanical services final design shall ensure:

1) All pipework shall be run in ceiling voids, service ducts, floor voids and discreetly hidden from view.
2) Good access shall be required to all main valves and commissioning stations.
3) All ductwork to run within ceiling voids and to drop and rises in given riser locations only.
4) General routing of services is to be undertaken in accordance with other sections of this Document maximising use of voids and rising shafts.
5) Sanitary accommodation is indicated on the Architect's Drawings, these shall be served by hot and/or cold services as required.
6) Louvres shall only be permitted in the areas indicated on the tender drawings.
7) Full co-ordination with all other services, building fabric, structural designs and architectural aesthetic requirements.

Summarised below are some of the items that require liaison with other trades, this list is not exhaustive and is provided to indicate the type of items that require detailed co-ordination.

Building final design shall ensure:

1) Access to services in risers, voids, etc.
1) Boxing requirements for pipework, etc.
2) Weights and structural implications.
3) External trenches.
4) Location and finish of all exposed equipment and pipework etc.

The coordinated drawings shall include for providing fully co-ordinated reflected ceiling plans (Scale 1:50).

6-1-17 DESIGN FOR ACCESSIBILITY, MAINTENANCE AND REPLACEMENT

The complete services installation shall be designed to facilitate current and future maintenance operations plus future replacement of the service / plant. The details below give minimum standards to be adopted in the design for various items. The list is not exhaustive and does not detract from the designer's obligation to meet current guidance such as the CDM Regulations, H&S requirements, Building Regulations etc.

FOR SERVICES, PLANT AND EQUIPMENT THE FOLLOWING SHALL BE PROVIDED:				
		DEDICATED PLANT AREAS	SERVICES RISERS, BELOW/ABOVE CEILING VOIDS AND FLOOR VOIDS	OCCUPIED AREAS
1)	Where services require frequent inspection / maintenance (i.e. every 6-12 months):			
a)	Access shall be easy and accomplished via purpose made panels without the need for special tools etc. (except where locking devices are used for safety purposes).	✓		✓
b)	Where practical, access shall be from a level surface avoiding the need for steps or the like wherever feasible (i.e. avoid routing services above staircases where access would be difficult).		✓	✓
c)	Access shall be from a level surface without the need for steps or the like.	✓	✓	
d)	Space shall be provided such that any consumable item can be easily removed and replaced without the use of any specialist lifting equipment.	✓		
e)	Access shall not be via ladders – staircases or preferably lifts shall be provided to all plant areas.	✓		
f)	Access for cleaning / inspection shall not be obstructed by adjacent services (e.g. do not route cable trays such that they obstruct duct access doors).		✓	
g)	Replacement shall be achieved without the need to damage the building fabric or finishes.			✓
2)	Where services require less frequent inspection / maintenance (i.e. every 1-5 years):			
a)	Access shall be unobstructed by adjacent services / plant.	✓	✓	✓
b)	Access shall be achieved without the need for specialist plant or machinery.	✓		

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FOR SERVICES, PLANT AND EQUIPMENT THE FOLLOWING SHALL BE PROVIDED:				
		DEDICATED PLANT AREAS	SERVICES RISERS, BULKHEADS, CEILING VOIDS AND FLOOR VOIDS	OCCUPIED AREAS
c)	Servicing / replacement shall be achievable without dismantling or affecting adjacent systems.	✓	✓	✓
d)	Maintenance and replacement terms shall not be located above user activity and operating zones within rooms, e.g. above laboratory benching, fixed equipment, fixed benching and desks etc.		✓	
e)	Where services require infrequent inspection, maintenance and/or replacement of complete items of plant:			
a)	A practical and safe method of replacement shall be provided along with suitable location for crane or the like.	✓		
b)	A practical and safe method of replacement shall be provided (such as removable bulkheads) along with suitable location for scaffolding or the like.		✓	✓
c)	Replacement shall be achieved in a cost effective manner, i.e. without excessive dismantling of the building facade, adjacent plant and services or disruption to the normal operation of the building.	✓	✓	✓
d)	The works shall be able to be completed in a relatively short period of time (less than 48 hours).	✓	✓	
e)	The works shall be able to be completed in a relatively short period of time (less than 4 hours). This shall be in a phased manner if necessary.			✓
f)	Maintenance and replacement terms shall not be located above end user activity and operating zones within rooms e.g. above laboratory benching, fixed equipment, fixed benching and desks etc.	✓	✓	
g)	Access shall be achieved from less sensitive spaces where feasible (i.e. from service corridors rather than the main entrance lobby).		✓	✓

Details of access for maintenance and replacement shall be provided in a design statement during the design process for comment and the agreed philosophies included in the O&M manuals upon completion of the works.

6-1-18 SAMPLES

To ensure that the quality of services fittings provided for the project is appropriate for the use of the facility, prior to any items being ordered the following samples shall be provided such that the Client may give any comments on the same.

If samples are provided that are deemed to be unsatisfactory as regards quality, aesthetics or robustness then provide alternative samples until an agreed solution is achieved.

Samples are required, at a very early stage of the project, for ALL services that will be exposed when the installation is complete. The following shall be provided for comment and the list is not exhaustive:

1) Grilles and Diffusers
2) Beverage water boiler / water chiller point of use unit
3) Each type of radiator and radiator valves
4) Bracket details – pipework and ductwork. This is particularly important where services are exposed.
5) Louvres
6) TMV3 mixing valve

In addition to the above it will be impractical to obtain samples of certain items and therefore full manufacturer's literature shall be provided in lieu of the same for the same agreement process. Items that fall under this heading are as follows:

1) Air cooled/free cooling chiller
2) Air handling plant
3) Dirty extract fans and any other fans
4) Heat exchangers
5) Buffer vessels / thermal stores
6) Central water heaters

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7) Control panels/MCC/BMS systems
8) Attenuators
9) Pumps
10) Cold water storage tanks
11) Booster sets
12) Proposed low and zero carbon technologies including photovoltaic arrays.

6-1-19 PRE-TENDER ENQUIRIES

Prior to issue of this tender enquiry to the marketplace, Couch Perry & Wilkes LLP have in some cases received quotations and budget costs from suppliers, manufacturers and specialist installers etc. If for any reason the tenderers receive a copy of this correspondence, please be aware that the contents of these have not been checked technically or commercially so shall be considered inaccurate and out of date.

All quotation enquiries to suppliers, manufacturers, specialist suppliers etc. shall be based on the tender design carried out by each tenderer.

6-1-20 NUMBER REFERENCING SYSTEMS

A number referencing system shall be established with the Engineer and Client, and where applicable be based upon the Client's facilities management System, for the switchgear, distribution boards, main plant, valves etc.

Individual circuit identification shall also be developed with the Engineer and Client.

6-1-21 LIFE EXPECTANCY OF THE INSTALLATIONS

The different systems provided for this project, including all equipment selected and installed, shall be chosen to at least meet the target life years listed in CIBSE Guide M section 12. Equipment which has obviously been selected purely on low capital cost shall not be permitted.

The preferred manufacturers list has been provided to indicate the type and standard of equipment required to be installed on this project. This preferred manufacturer's list shall not be deviated from unless agreed in writing from the design team.

6-2 ACCESS HATCHES

Include and provide all due allowance of access hatches in ceiling and walls to provide free and easily access to all valves, dampers, fan coil units, fire dampers and other service requiring maintenance. Design out all access hatches where possible where accessible ceilings are provided.

All access hatches shall be suitable for the fire rating of the building element installed and shall be fire sealed where necessary. The access hatches shall be hinged type with secondary safety wire to prevent the accidental failing of hatches from high level.

The Access hatches shall be fully co-ordinated with the architect and the reflective ceiling plans generated for comment prior to installations commencing on site. The RAL colour of all hatches shall be confirmed with the project architect prior to procurement.

Under no circumstances shall plant items including heat recovery units, extract fans, volume control dampers, pipework valves etc be located above areas with residential access including en-suite, bedrooms, day rooms and circulation areas. All such plant and associated components shall be designed and arranged accordingly and be located above back of house ancillary areas such as store or sluice rooms. Pipework valve access shall be permitted within the en-suites and grouped together to limit access through a single panel.

6-3 AVOIDANCE OF WATER SERVICES AND ELECTRICAL ROOMS AND HUB ROOMS

No wet services shall be installed or pass through rooms that are either electrically intensive or house electronic panels / racks, this includes, but is not limited to, data rooms, hub rooms, data centres, high voltage (HV) rooms and low voltage (LV) rooms.

To clarify this point, no piped rainwater or soil drainage, DHWS, heating or chilled water pipes shall be within these areas, with the exception of refrigerant and condensate piped that serve local cooling installed to cool these rooms only. With regards to refrigerant and condensate services that must be brought into some of these rooms, these will take a direct route in e.g. will enter the room back entry into the wall mounted units.

6-4 ROOM DATA SHEETS

Obtain copies of the room data sheets during the tender period to ensure all costs associated with the services requirements listed in the room data sheets is included for at tender. Room data sheets shall only quantify level for the Building Services on a room by room basis so the room data sheets shall be read in conjunction with concept tender drawings and this specification.

Room data sheets, this specification and tender drawings shall be read and priced together to determine the complete design requirements. The concept drawings include areas that may not be listed on the room data sheets hence the requirement to review the full scope of works in each room / area to comply with the requirements of this complete tender package.

If quantities noted on the room data sheets differ to the design intent drawings, the higher quantity (more onerous) shall be allowed for at tender.

ANY CONFLICTING PROVISIONS BETWEEN THE EMPLOYER'S REQUIREMENTS AND THE CONTRACTOR'S PROPOSALS MUST BE ADVISED TO THE EMPLOYER'S AGENT DURING THE TENDER PROCESS FOR CLARIFICATION.

IF NO CONFLICT/QUALIFICATION IS MADE AND IN THE SUBSEQUENT EVALUATION A CHANGE IS FOUND, THE TENDERER SHALL BE ASKED TO ACCEPT COMPLIANCE WITH THE EMPLOYER'S REQUIREMENTS AT NO EXTRA CHARGE OR WITHDRAW THEIR TENDER. ANY DIVERGENCES FOUND SUBSEQUENT TO THE CONTRACTOR'S APPOINTMENT SHALL BE DEALT WITH IN ACCORDANCE WITH THE CONTRACT CONDITIONS.

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6-5 INTERNAL DESIGN CONDITIONS

6-5-1 INTERNAL MECHANICAL DESIGN CONDITIONS

The room data sheets shall be consulted in conjunction with the following general requirements and the most onerous condition taken as the design requirement for the space in question.

The values listed are design values so the services shall be sized to suit these values not taking into account the dead band control parameters.

Occupancy levels listed are those that shall be used to calculate fresh air duties and heat gains. No diversities shall be considered regarding fresh air allowances or heat gains.

The table below gives indicative internal room noise level criteria in the event that these are not described with the above documentation or room data sheets. The information shall be reviewed and if any ambiguity is identified the most onerous design criteria shall be used and all costs allowed for at tender.

MECHANICAL INTERNAL DESIGN CONDITIONS – GENERAL REQUIREMENTS

ROOM / AREA	WINTER °C	SUMMER °C	SERVICES NOISE LEVEL (NR)	HEATING SYSTEM	COOLING SYSTEM	VENTILATION	VENTILATION SYSTEM
	OPERATIVE	OPERATIVE					
Bedrooms	Minimum 23°C	CIBSE TM59	NR25	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
En-suites	Minimum 23°C	Uncontrolled	NR25	Indirectly via bedroom heater	n/a	Mechanical based on 8 l/sec trickle & 20 l/s boost.	Local Extract Fan
Assisted Bathrooms	Minimum 23°C	Uncontrolled	NR35	DIRECT ELEC LST Radiators	n/a	Mechanical based on 5 ACH trickle / boost	Local Extract Fan
General WC's / Assisted WC's (not residential)	Minimum 23°C	Uncontrolled	NR40	DIRECT ELEC LST Radiators	n/a	Mechanical based on 5 ACH trickle / boost	Local Extract Fan
Sluice Rooms	Minimum 22°C	Uncontrolled	NR40	Indirectly via adjoining rooms	n/a	Mechanical based on 5 ACH trickle / boost	Local MVHR Unit
Staff Changing	Minimum 21°C	Uncontrolled	NR35	DIRECT ELEC Radiators	n/a	Mechanical based on 4 ACH	Local Extract Fan
Staff Rooms	Minimum 22°C	Cooled refuge 22°C.	NR35	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural	Natural via opening windows plus trickle vents
Nurse / Care Offices	Minimum 23°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC Radiators	n/a	Mechanical 12 l/s/person	Local MVHR Unit
Drugs Store / Clinical Room	Minimum 21°C	Maximum 22°C	NR35	DX Wall Mounted AC System	DX Wall Mounted AC System	Mechanical based on 5 ACH trickle / boost	Local Extract Fan

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Hairdressing Salon	Minimum 23°C	28°C not exceeded by more than 1% of occupied hours	NR37	DIRECT ELEC LST Radiators	n/a	Mechanical based on 6 ACH	Local Extract Fan
Treatment Rooms	Minimum 22°C	Cooled refuge 22°C.	NR35	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Mechanical based on 5 ACH trickle / boost	Local Extract Fan
Corridors and Staircase	Minimum 21°C	Uncontrolled	NR35	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
Foyer / Reception	Minimum 21°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
Draught Lobby	Minimum 18°C	Uncontrolled	NR45	ELEC Overdoor Heater	n/a	Natural	Natural via opening windows plus trickle vents
Household Lounge	Minimum 22°C	Cooled refuge 22°C.	NR35	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural	Natural via opening windows plus trickle vents
Garden Lounge	Minimum 22°C	Cooled refuge 22°C.	NR35	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural	Natural via opening windows plus trickle vents
Tea Room / Shop	Minimum 23°C	Cooled refuge 22°C.	NR37	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural	Natural via opening windows plus trickle vents
Seating Area	Minimum 23°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
E-learning	Minimum 23°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC LST Radiators	n/a	Mechanical 12 l/s/person	Local MVHR Unit
Terrace Lounge	Minimum 23°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
Household Dining Room	Minimum 22°C	Cooled refuge 22°C.	NR35	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural	Natural via opening windows plus trickle vents

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Household Kitchen Servery	Minimum 22°C	Cooled refuge 22°C.	NR40	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Natural plus mechanical extract to kitchen / servery area based on 4 ACH or min 60 l/sec which ever greater.	Natural via opening windows plus trickle vents Local Extract Fan
Reading Rooms	Minimum 22°C	28°C not exceeded by more than 1% of occupied hours	NR30	DIRECT ELEC LST Radiators	n/a	Natural	Natural via opening windows plus trickle vents
Cinema Room	Minimum 22°C	Cooled refuge 22°C.	NR30	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Mechanical based on ACH 3 ACH or 12 l/s/person which ever greater.	Landlocked Rooms - Local MVHR Unit
Admin Offices	Minimum 21°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC Radiators	n/a	Natural unless landlocked in which case provide 3 ACH or 12 l/s/person whichever greater	Natural via opening windows plus trickle vents Landlocked Rooms - Local MVHR Unit
Tea Points & kitchenette	Minimum 21°C	Uncontrolled	NR37	DIRECT ELEC LST Radiators	n/a	Mechanical based on 4 ACH or 12 l/s/person or min 60 l/sec which ever greater.	Local Extract Fan
Meeting rooms	Minimum 21°C	28°C not exceeded by more than 1% of occupied hours	NR35	DIRECT ELEC Radiators	n/a	12 l/s per person	Local MVHR Unit
Laundry	Minimum 18°C	Maximum 22°C	NR45	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Mechanical based on 10 ACH plus Specialist supply and exhaust ventilation	Local MVHR Unit Dryer exhaust and make up system.
Staff showers	Minimum 21°C	Uncontrolled	NR40	DIRECT ELEC Radiators	n/a	Mechanical based on 6 ACH	Local Extract Fan
Plant Room	15°C minimum	Maximum 35°C	NR65	DIRECT ELEC Radiators	n/a	Mechanical and Natural - high / low level	Mechanical and Natural - high / low level
Server / Comms Room	Minimum 21°C	Maximum 22°C	NR45	DX Wall Mounted AC System	DX Wall Mounted AC System	No requirement	No requirement
Store Rooms	Minimum 16°C	Uncontrolled	NR45	Indirectly via adjoining rooms	n/a	None	n/a

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Cleaners Store	Minimum 16°C	Uncontrolled	NR45	Indirectly via adjoining rooms	n/a	Mechanical based on 2 ACH	Local Extract Fan
Kitchen	Minimum 18°C	Shall comply with CIBSE TM50 and BESA DW172	NR45	VRF Ceiling Mounted AC System	VRF Ceiling Mounted AC System	Mechanical based on 60 ACH.	Dedicated extract fan (SFP 1.0) and supply fan
Kitchen Dry Store	Minimum 18°C	Shall comply with CIBSE TM50 and BESA DW172	NR45	DIRECT ELEC Radiators	n/a	Mechanical based upon 10 ACH	Supply and Extract Fans
Chefs Office	Minimum 18°C	28°C not exceeded by more than 1% of occupied hours	NR40	DIRECT ELEC Radiators	n/a	Mechanical 12 l/s/person	Local Extract Fan

Notes
(1) The noise ratings shall relate to the noise rating method with the distance being 1 metre from equipment or noise generation into room when all systems are running. The above are only indicative for the purpose of tender.
(2) Litres per second per person values are minimum requirements that may need to be increased following thermal modelling to achieve required peak summertime temperature requirements.

6-6 EXTERNAL AMBIENT DESIGN CONDITIONS

The mechanical services installations shall be designed to provide the specified internal environmental parameters when the building is subject to the following external conditions:

EXTERNAL AMBIENT DESIGN STANDARDS	
DESCRIPTION	CONDITION
Winter external (fabric)	As per CIBSE Guide A table 2.5 for external temperatures not exceeded for more than 0.4% of year (use the 99.6% not exceeded column). As an example only, for Birmingham use -5.1ºC dry bulb / -5.2ºC wet bulb.
Winter external (design condition for plant selection)	As per CIBSE Guide A table 2.5 for external temperatures not exceeded for more than 0.4% of year (use the 99.6% not exceeded column). As an example only, for Birmingham use -5.1ºC dry bulb / -5.2ºC wet bulb.
Summer external for design condition for chiller and refrigeration plant capacity selection	As per CIBSE Guide A table 2.6 for external temperatures not exceeded for more than 0.4% of year (use the 99.6% not exceeded column). As an example only, for Birmingham use 26.3ºC dry bulb / 18.9ºC wet bulb.
Summer external for design condition for cooling coil selection	As per CIBSE Guide A table 2.6 for external temperatures not exceeded for more than 0.4% of year (use the 99.6% not exceeded column) PLUS 2ºC. As an example only, for Birmingham use 28.3ºC dry bulb / 20.9ºC wet bulb.
External conditions for output from chillers and condensing units	Winter: minus 10°C / Summer: 35°C dry bulb due to enclosed chiller compound causing local climate extremes.
Maximum noise level (With all plant operating at peak output, 3m from building perimeter)	5 dB below current ambient level or Building Control OR Acoustic Report OR Planning requirements, use lowest value whichever is the most onerous.
Carbon emissions modelling for Part L and energy calculations	CIBSE Test Reference Year, nearest geographical location of similar conditions available.
Summertime thermal analysis	CIBSE Design Summer Year, nearest geographical location of similar conditions available.
Summertime temperature	CIBSE Design Summer Year, nearest geographical location of similar conditions available.
Climate Change Impact Assessment	CIBSE Test Reference Year, nearest geographical location of similar conditions available for 2020 and 2050.
All the above design values shall be corrected for altitude where the project site is at a significantly different altitude to the reference data (significant defined as 300m for this assessment) – Refer to CIBSE Design Guides A and B1 for guidance.	

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6-7 LTHW HEATING SYSTEM

6-7-1 DESIGN REQUIREMENTS

LTHW systems shall be designed to achieve a number of criteria including:

1) Air to water air source heat pump plant efficiencies to meet the specified building energy performance requirements.
2) Maintain design conditions within the spaces served.
3) Provide an acceptable and comfortable environment.
4) Minimise energy use and waste.
5) Maximise efficiency.
6) Ensure simple / practical operation and maintenance.
7) Satisfy peak simultaneous LTHW load requirements.

CENTRAL LTHW HEATING EQUIPMENT DESIGN REQUIREMENTS	
DESCRIPTION	REQUIREMENT
Central Air to Water Air Source Heat Pump	2 No. each rated at 66% of total heat load
ASHP thermal efficiencies	As required to meet the EPC requirements.

The following temperatures / efficiencies shall be adopted for the various systems design unless advised otherwise in the particular sections of this specification:

LTHW HEATING SYSTEMS DESIGN OPERATING CONDITIONS		
DESCRIPTION	FLOW °C	RETURN °C
Primary / Boiler LTHW Circuit	65°C	< 55°C
LTHW Constant Temperature circuit	63°C	55°C
Where secondary circuits are hydraulically separated from the primary circuit by a plate heat exchanger the secondary temperatures shall be reduced by the exchange approach (ideally 2 kelvin).		

The project specific requirements section of this specification shall be referred to as it may modify some of the above design criteria.

Peak heating loads shall be calculated for each space and an appropriate emitter selected taking account of margins for flexibility, transient use, warm up, etc. Pipework distribution shall be designed to supply the necessary flow rate for the above plus allowance for distribution system losses and design margins.

The total heating load for central plant shall be calculated by assessing the maximum simultaneous heat demand of all heating emitters served together with all pipework heat losses, construction errors, early morning boost and any redundancy / expansion specified.

Margins etc. shall be calculated in accordance with CIBSE guides subject to the following minimums:

MINIMUM MARGINS FOR LTHW HEATING DESIGN	
DESCRIPTION	MARGIN TO BE INCLUDED IN DESIGN
Construction errors	To be assessed by the designer
Flexibility, added to base room heat loss	+10%
Boost, applicable when area is not occupied 24 Hours.	+5%
Pipework distribution losses	+5%
Heat Recovery Ventilation Allowances	Assume all the heat recovery devices is operating at 80% of original design performance due to reduced heat transfer from age or fouling.
Pipework Sizing Capacity	Maximum simultaneous load of loads shall be allowed assuming that only the largest heat recovery unit has degraded or failed (as appropriate) so the corresponding LTHW coil output has increased to compensate and including all margins for construction error, flexibility, boost and pipework losses.
Central Plant Capacity	Central plant shall be sized to meet the normal design operation including construction error, flexibility, boost and pipework losses margins with no allowance for the failure or degradation of the ventilation heat recovery systems.

6-7-2 LTHW DESIGN AND PIPEWORK SIZING

The heating pipework installations shall be designed to the recommendations laid down in the CIBSE guide to current practice and in particular the following:

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1) Based on the design principles detailed in the tender schematics.
2) Variable speed pumping and two port control shall be employed wherever practical following the principles laid down in the CIBSE Knowledge Series.
3) Heating system maximum pipework velocities shall be as detailed in the CIBSE guide dependent upon pipe size.
4) Heating system maximum pipework pressure drop shall be limited to 200 Pascal per metre, except after DPCVs.
5) Maximum setting downstream of all DPCV valves shall be 30kPa differential pressure.
6) All pipework distribution downstream of the DPCV shall be a low pressure loss design typical no more than 100 Pascal per metre.
7) Any pressure independent control valves (PICVs) shall not be operating within the upper 25% of their preferred maximum differential pressure.
8) Circulating pumps shall vary flow rate via differential pressure transducers and a proportional pressure control methodology. Small systems, with a flow rate of 1.5kg/s or less, shall have integral inverters and pressure control. Larger systems shall be provided with inverters that are separate from the pumps.
9) Have a method of reducing flow to very low levels (less than 5%) by using multiple pumps, a jockey pump or other manufacturer's recommended method.
10) Any minimum flow requirements shall not be provided by permanent bypass pipes, with or without manual adjustable valves. Automatic bypass valves shall only be used to satisfy minimum pump flow rate.
11) Temperature maintaining valves, set at design return temperature, shall be provided at strategic locations on large systems or systems incorporating combined heat and power (CHP) systems to ensure that mains are maintained at a sufficiently high temperature to ensure heat is available to all terminal devices and is provided in a timely manner and ensure the return water temperature is as low as possible.
12) Any flow maintaining devices proposed to satisfy minimum pump flow rate requirements shall be installed before any local zone valves.
13) Coils shall be piped counter flow and not parallel flow configuration.
14) All best practice design guidelines from equipment and valve manufacturers shall be adopted in the overall design.
15) Water pipes shall not be routed within 2 metres of any control panel or distribution board in plant rooms.
16) Ensure that minimum flow requirements are achieved at all emitters that require turbulent and therefore minimum flow rates to operate correctly and meet the required emitter outputs. Generally, for the emitters used in the building services industry this means:
    a) Radiators and natural convectors are not subject to any minimum flow requirements to meet their required outputs.
    b) Trench heating, radiant panels, fan convectors, unit heaters and door curtains are subject to achieving minimum flow rates to ensure turbulent flow occurs so both variable heat output and design heat output can be achieved. This is a known issue with smaller radiant panels where flow rates are calculated without considering the minimum flow rate requirements advised by the panel manufacturers.
    c) Fan assisted or forced draught emitters shall not produce draughts when operating due to laminar flow of the heating fluid through the emitters.
    d) Air handling unit coils flow rates and coil selections are determined by the AHU manufacturer to ensure turbulent flow so laminar flow should not be a concern for the range of control valve control.
    e) The designer must always obtain specific design advise from the emitter manufacturer to determine if any minimum flow requirements for the proposed emitter and must incorporate this information into the detailed design.

6-8 DOMESTIC HOT AND COLD WATER SYSTEMS

6-8-1 DESIGN REQUIREMENTS

The hot and cold water services shall be designed to satisfy the following requirements:

1) The design philosophy for the domestic hot and cold water services shall be as detailed on the tender schematic. The overall philosophy for the design have been agreed with the design team and client prior to tender so the detailed design shall be developed on this basis and alternative design solutions shall not be adopted.
2) Provide potable drinking water to all drinking water outlets.
3) Water to drinking points shall be fed direct from the utility mains or via a specific booster set and low volume break tank (not large cold water storage tank) as detailed on the tender drawings.
4) All wash hand basins and sinks shall be thermostatically blended to TMV3 standards throughout the project. The only exception shall be some sinks such as cleaners and other non-resident sinks. Where no TMV is provided a sign shall be provided to state 'Caution Hot Water'.
5) Local pressure static and dynamic type combined reducing valves shall be provided to limit pressure and supply to outlets. Pressure reducing valves shall be fail closed type and shall be installed at each floor to ensure even and equal pressure at all outlets. It is expected that flow restrictor isolation valves shall aid in meeting this requirement.
6) Hot and cold water is readily available to all outlets to satisfy guidelines regarding the risk of legionella growth in relation to minimal dead legs.
7) The whole design must be in accordance with the HSE Approved Code of Practice L8.
8) Ensure discharge flow rates are maintained at all outlets during peak predicted demand.
9) Cold water distribution shall be designed to ensure that the cold water outlet achieves 20°C or less within 2 minutes of the outlet being fully open. This is a statutory requirement (where the incoming mains cold water is 20°C or less).

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10) On unblended circuits, hot water distribution shall be designed to ensure that the hot water outlet achieves at least 55ºC within 1 minute of the outlet being fully open. This is a statutory requirement.

11) On thermostatically blended circuits, hot water distribution shall be designed to ensure the hot water outlet achieves the set point temperature of the thermostatic mixing valve within 1 minute AND the unblended hot water achieves 55ºC at the same time. This is a statutory requirement. Testing shall be carried out in accordance with the methodology detailed in Thermostatic Mixing Valve Manufacturers Association their document 'Recommended Code of Practice for Safe Water Temperatures'.

12) On circulating systems, non-circulating dead legs shall not exceed 0.5 litre to the outlet in accordance with BS8558 so although the 'traditional' dead leg limit of 3 metres, for 15mm copper pipe, is compliant with this requirement all larger pipe dead legs will need to be shorter to achieve the 0.5 litre limit in the British Standard.

13) Hot water circulating systems shall be provided with a combination of thermostatic circulating valves (also known as self-acting thermostatic recirculation valves) shall be installed throughout the hot water return installation fully in accordance with the manufacturers recommendations. Thermostatic circulating valves are specified outright for the project as they automatically compensate and self-balance circuits when initially installed and also if circuits are modified at a later date. Thermostatic circulating valves shall have integral facility to fully open at increased temperatures to allow for regular system pasteurisation.

14) Under no circumstances shall lock shield valves be installed for hot water recirculation regulation as they cannot be easily or accurately reset to commissioned flow rates following routine isolation and this represents an unacceptable risk of poor circulation and bacteria propagation.

15) Hot water branches shall normally be designed so that only a single thermostatic circulating valves is required on each branch with the necessary dead legs to multiple outlets designed within the dead leg limits listed above. Where this is NOT possible and sub-branch circuits are required then each of the sub-branch circuits shall be fitted with double regulating valves to allow thermal balancing of these sub-circuits only. On this basis no circuit should need more than two double regulating valves on any one branch that already has a thermostatic circulating valve. Double regulating valves shall not be used as a cost saving in place of thermostatic circulation valves.

16) Where cold water pipes are routed adjacent to hot water and heating pipes the cold water pipes shall be located a minimum of 100mm clear of the hot pipes. Clear distance is between the fully insulated pipes and not bare / un-insulated pipes.

17) Where cold water pipes are routed horizontally adjacent to hot water and heating pipes the cold water pipes shall be located below the hot pipes.

18) When designing the bracket arrangement for the hot and cold water services ensure that thermal transfer between the pipes is minimised. For example, known thermal transfer issues occur where insulated plastic pipes are installed on galvanised steel cable tray for continuous support so this type of design shall be avoided.

19) Booster sets, where used, shall incorporate measures to prevent excessive surge / velocity pressures when re-starting after a fault condition / mains failure.

20) Back flow and back pressure prevention shall comply with current water regulations based on the fluid category. Note that reduced pressure zone (RPZ) valves shall NOT BE USED.

21) Outlets to be provided with means of adjusting pressure to prevent splash over or overflow of sanitary ware. Flow restrictor valves shall meet this requirement provided those chosen are pressure independent at the expected peak operating pressure.

22) Complete system shall be protected against excessive pressure during periods of low demand where utility mains pressure may exceed.

23) Maximise system and pipework distribution efficiency.

24) Minimise water waste and energy use.

25) Ensure simple and practical operation for ease of use and maintenance.

26) BMS monitored temperature sensors shall be provided as detailed on the tender drawings and in accordance with the industry best practice guidelines (e.g. HTM 04-01).

27) Flushing and disinfection points shall be provided based on the guidance within PD 855468.

28) Within plant rooms, no water pipes shall be routed within 2 metres of any electrical switch panel or BMS control panel and as advised later in this section no water services are permitted at all in certain electrical rooms.

6-8-2 DOMESTIC HOT AND COLD WATER SYSTEMS

The following conditions shall be adopted for the domestic hot and cold water systems design unless advised otherwise in the particular sections of this specification:

DOMESTIC HOT AND COLD WATER SYSTEMS OPERATING / DESIGN CONDITIONS	
DESCRIPTION	CONDITION
Minimum pressure at outlets	0.5 bar gauge (or sanitary ware manufacturer's minimum requirement whichever is greater)
Maximum pressure at outlets	As dictated by the height of the building and booster sets. Flow Restrictor Isolation Valves shall be installed to prevent excessive flow and pressure.
Differential pressure between hot and cold water outlets when mixing	Not to exceed that recommended by the thermostatic mixing valve manufacturer and should be as equal pressure as practical.
Pressure available from utilities mains	0.7 bar gauge (unless guaranteed in writing to be higher by utility company)
Flow rates	For residential projects only, BS EN 806-3 shall be used to calculate flow rates.

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DOMESTIC HOT AND COLD WATER SYSTEMS OPERATING & SIZING CONDITIONS	
DESCRIPTION	CONDITION
	For all other projects Loading Units as detailed on Annex C of BS 8558 shall be used to calculate flow rates. Where outlets are blended the hot water use shall be amended to suit the blended temperature.
Pipe Sizing	CIBSE guide to determine all pipe sizes based on calculated flow rates.
Maximum pipework velocities.	As detailed in CIBSE guide dependent upon pipe size.
Pipework pressure drop	Calculated according to the available head on the system and as required to give correct flow at terminal outlets and the avoidance of below atmospheric pressure conditions in return circuits.

6-8-3 ADDITIONAL DOMESTIC HOT WATER SYSTEM REQUIREMENTS

The following conditions shall be adopted for the domestic hot water systems design unless advised otherwise in the particular sections of this specification:

DOMESTIC HOT WATER SYSTEMS ADDITIONAL OPERATING & SIZING CONDITIONS	
DESCRIPTION	CONDITION
Hot Water Flow Temperature	60°C
Minimum Hot Water Return temperature	50°C
Maximum outlet temperature for thermostatically blended outlets	As specified in HTM 04-01 'Executive Summary' table except all mixing valves shall be TMV 3 throughout.

6-8-4 ADDITIONAL DOMESTIC COLD WATER SYSTEM REQUIREMENTS

The following conditions shall be adopted for the domestic cold water systems design unless advised otherwise in the particular sections of this specification:

DOMESTIC COLD WATER SYSTEMS ADDITIONAL OPERATING & SIZING CONDITIONS	
DESCRIPTION	CONDITION
Cold water Storage	20°C or no more than 2 degrees C above the incoming water temperature if greater than 20ºC.
Cold water at outlets (general)	20°C under normal use or as advised by the local water utility company.
Cold water at outlets (drinking)	20°C under normal use or as advised by the local water utility company. Chilled water temperatures shall be at the same temperature as the set point of the water chiller (i.e. no allowance for any temperature gain).
Infrequently Used Cold Water Outlets	Cold water dead legs shall be limited to 300mm on infrequently used outlets (i.e. pressurisation units, outdoor taps etc.) Any future or fit out connections shall be arranged such that no dead leg is presented in the short term.
Cold Water Tank Location	Cold water storage shall be arranged such that storage temperatures do not exceed 20°C by use of tank positioning, multiple tanks operating in series, insulation, and adjustable volume to allow turnover to be accurately matched to actual demand.
Cold Water Tank Sizing	Storage to be based upon 2 hours of peak calculated demand.

6-8-5 HOT AND COLD WATER CATEGORY 5 SUPPLIES

Where supplies are provided to areas that require category 5 protection (i.e. bin store etc.) as defined in the current water regulations these shall:

1) Be served via a break tank complete with AA or AB air gap
2) Be boosted as necessary to meet the required supply pressure.
3) Be otherwise designed in the same manner as domestic water supplies.

6-9 VENTILATION SYSTEMS

6-9-1 VENTILATION DUCTWORK SIZING

All ductwork systems shall be designed in accordance with the recommendations laid down in the CIBSE guide to current practice and the following parameters:

1) General supply and extract velocities within ductwork systems shall be limited to:

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MAXIMUM DUCTWORK AIR VELOCITIES (m/s)	NOISE RATING LIMIT			
DESCRIPTION	NR 42	NR 38	NR 33	NR 28
Main ducts within plant rooms	6.0 m/s	5.0 m/s	4.0 m/s	3.0 m/s
Main ducts in risers	5.5 m/s	4.5 m/s	4.0 m/s	3.0 m/s
Main ducts within ceiling voids and exposed to view	4.5 m/s	3.0 m/s	2.5 m/s	2.5 m/s
Branch ducts	4.0 m/s	3.0 m/s	2.5 m/s	2.5 m/s
Final run outs	2.5 m/s	2.0 m/s	<2.0 m/s	<2.0 m/s
Ductwork Velocities shall be finally agreed with relevant parties but the above values shall not be exceeded. Should the relevant parties, such as Project Acoustician, require lower values than stated above then those shall be adhered to. If no Acoustic Consultant advice is available then the above limits shall not be exceeded however these maximum velocities may need to be reduced to meet the required room Noise Rating values. **The overriding requirement is for the rooms to achieve their design Noise Ratings.**				

2) The maximum pressure drop per metre run of ductwork shall be limited to 0.5 Pascal's per metre run on supply and extract systems. This pressure limit may be reviewed in a very few number of specific local cases where pinch points occur, should any relaxation occur this shall:
   a) Be fully compensated for elsewhere in the same system.
   b) Have no detrimental effect on system performance in terms of conditions / noise levels in the occupied space, energy consumption proportional balancing to avoid regulation of VCD's.
   c) Not be applied generally across the system, only to local occurrences with the written consent of the Engineer.
3) Ductwork shall be sized on a constant pressure drop basis throughout all systems with balancing dampers as required. Ensure that all final dampers' locations do not cause noise regeneration that is audible in the rooms.
4) Should the above criteria need to be improved upon (i.e. lower velocities and pressure drops per unit length) to meet Part L carbon, energy and project criteria then these shall be adopted for the design allowance at tender.
5) Any variable air volume (VAV) systems shall not incorporate any diversity when the ductwork is sized as the VAV is provided to save energy and not to limit occupancy or use of the building due to insufficient airflows or non-compliant noise levels when the ventilation system is required to operate at peak airflow.

6-10 ABOVE GROUND DRAINAGE

The above ground drainage shall be designed to be fully in accordance with BS EN 12056. Material and type of systems are detailed on the tender drawings and Above Ground Drainage Section of this Specification.

6-11 ENERGY METERING SYSTEMS

The design criteria for the energy metering systems are detailed in the Energy Metering Section of this Specification as the metering shall be designed by the energy metering specialist.

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6-12 APPENDIX A – PRELIMINARY ENERGY MODELLING

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6-13 APPENDIX B – PREFERRED MANUFACTURERS LIST

MECHANICAL SERVICES

Air Handling Units: Dalair / Birmingham Air conditioning / Nuaire
Volume Control Dampers: Actionair Air Shield and Aeroseal Range
VAV Boxes: Trox/Advanced Air/Krantz
Fire / Smoke Dampers: Actionair Fire Shield and Smoke Shield PTC Range
Pumps: Holden and Brooke / Pullen / Grundfos
Air to water air source heat pumps: Strebel heating technology
Hot water service calorifiers: Hamworthy
VRV / DX units: Daikin
Water Valves and commissioning sets: Crane / Hattersley / Tour and Anderson/Oventrop
Dirty Extract Fans: Nuaire / Vent Axia
Pressurisation Units: Same as manufacturer of pumps
Ceiling Grilles and general Diffusers: TEK Limited or direct equivalent
Attenuators: TEK Limited or direct equivalent
Boiling/Chilled water units/fountains: ZIP
Air / dirt Separators: TA Hydronics
Expansion bellows: BOA group

Note – Where multiple quantities of the same type of equipment is required such as pumps, air handling units, etc. the same manufacturer shall be used throughout the installation.

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BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

LITTLE HAMPTON CARE HOME TENDER ISSUE (160m2)

As designed

Date: Fri Sep 25 11:11:56 2020

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.12

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.12

BRUKL compliance check version: v5.6.a.1

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: COUCH PERRY WILKES

Telephone number: 0121 709 6600

Address: INTERFACE 100 ARLESTON WAY, SOLIHULL, B90 4LH

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	40.5
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	40.5
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	40.4
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	L0000055:Surf[1]
Floor	0.25	0.17	0.17	L0000060:Surf[8]
Roof	0.25	0.17	0.17	L0000055:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.12	1.12	L0000070:Surf[5]
Personnel doors	2.2	1.1	1.1	L0000136:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- Direct Electric Heating and Local Extract

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	1	-	0.67	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

2- Direct Electric Heating and Mechanical ventilation with Heat Recovery unit

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	1	-	0.67	0	0.65
Standard value	N/A	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

3- Direct Electric Heating and Natural Ventilation

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	1	-	0.67	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

4- Direct Electric Heating and Zonal Extract

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	1	-	0.67	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

5- LTHW Heating & VRF AC - Kitchen

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3.75	3.5	0	0	-
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

6- LTHW Heating & VRF AC - Lounge

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3.75	3.5	0	0	0.65
Standard value	2.5*	3.2	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L01 : 202 ASSITED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 43	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 44	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 41	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 42	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 197 SERVERY	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 198 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : ENSUITE 38	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 37	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 46	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 47	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ASISTED BATH 101	-	-	0.5	-	-	-	-	-	-	-	N/A
L01 : COMMERCIAL KITCHEN	-	0.5	1	-	-	-	-	-	1	-	N/A
L01 : COMMERCIAL KITCHEN	-	0.5	1	-	-	-	-	-	1	-	N/A
L01 : ENSUITE 48	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 182 STAFF ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : ENSUITE 34	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 35	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 45	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 36	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 110 TREATMENT ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 141 CLINICAL ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : COMMERCIAL KITCHEN	-	0.5	1	-	-	-	-	-	1	-	N/A
L01 : 125 ASSISTED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 196 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : ENSUITE 39	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 40	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 33	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : CLINICAL ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : CARE OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : ENSUITE 59	0.3	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L01 : ENSUITE 60	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 58	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 57	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 61	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 63	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 64	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 49	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 50	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 51	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 52	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 54	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 55	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 56	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : ASSISTED BATH 138	-	-	0.5	-	-	-	-	-	-	-	N/A
L01 : ASSISTED BATH 138	-	-	0.5	-	-	-	-	-	-	-	N/A
L01 : ENSUITE 62	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 051 ENSUITE 05	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 053 ENSUITE 06	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 055 ENSUITE 07	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 057 ENSUITE 08	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 031 HOUSEHOLD LOUGE 01	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 026 SEATING AREA	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 032 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 033 SERVERY	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 036 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L00: 078 ENSUITE 09	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 076 ENSUITE 10	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 074 ENSUITE 11	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 072 ENSUITE 12	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 069 ENSUITE 13	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 065 ENSUITE 14	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 063 ENSUITE 15	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 061 ENSUITE 16	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 058 ASSISTED BATH	-	-	0.5	-	-	-	-	-	-	-	N/A
L00 : 058 ASSISTED BATH	-	-	0.5	-	-	-	-	-	-	-	N/A
L00 : 016 SHOP AND TEA ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 009 LOUNGE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 012 HAIR SALON	-	-	0.5	-	-	-	-	-	-	-	N/A
L00 : 082 CARE OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 048 ENSUITE 04	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 044 ENSUITE 03	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 042 ENSUITE 02	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 040 ENSUITE 01	0.3	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L00 : 025 CLINICAL ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 024 CARE OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 029 ASSISTED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 020 CLEAN LAUNDRY LAUNDRETTE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 004 ADMIN OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 003 MANAGERS OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 010 ASSISTED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 088 SERVERY	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 092 ASSISTED BATHROOM	-	-	0.5	-	-	-	-	-	-	-	N/A
L00 : 092 ASSISTED BATHROOM	-	-	0.5	-	-	-	-	-	-	-	N/A
L00 : 099 ENSUITE 32	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 101 ENSUITE 31	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 103 ENSUITE 30	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 107 ENSUITE 29	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 :110 ENSUITE 28	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 112 ENSUITE 27	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 114 ENSUITE 26	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 116 ENSUITE 25	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 090 HOUSEHOLD LOUNGE 04	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 007 DOC M WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 130 ENSUITE 20	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 132 ENSUITE 19	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 136 ENSUITE 17	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 085 ASSISTED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 082 CARE OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00: 123 ENSUITE 22	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 121 ENSUITE 23	0.3	-	-	-	-	-	-	-	-	-	N/A
L00: 119 ENSUITE 24	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 087 HOUSEHOLD LOUNGE 03	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 086 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 037 HOUSEHOLD LOUNGE 02	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : 019 DIRTY LAUNDRY	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 140 CARE OFFICE	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 141 CLINICAL ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 116 ASSISTED WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 002 FOYER	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 170 HOUSEHOLD LOUNGE	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 0.026 SEATING AREA	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 199 HOUSEHOLD LOUNGE 199	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : TERRACE LOUNGE 173	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : HOUSEHOLD LOUNGE 167	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 168 HOUSEHOLD LOUNGE	-	-	-	1.3	-	-	-	-	-	-	N/A
L00 : ENSUITE 18	0.3	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L01 :	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 0.088 SERVERY	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : DINING ROOM 0.086	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 186 F WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 185 F WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 126 STAFF SHOWER	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 209 STAFF SHOWER	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 210 STAFF SHOWER	0.3	-	-	-	-	-	-	-	-	-	N/A
L01 : 211 STAFF CHANGING	-	-	-	1.3	-	-	-	-	-	-	N/A
L01 : 128 M WC	0.3	-	-	-	-	-	-	-	-	-	N/A
L00 : 089 DINING ROOM	-	-	-	1.3	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
L01 : 202 ASSITED WC	-	90	-	45
L01 : ENSUITE 43	-	97	-	28
L01 : ENSUITE 44	-	97	-	29
L01 : ENSUITE 41	-	97	-	26
L01 : ENSUITE 42	-	97	-	29
L01 : 197 SERVERY	-	90	-	50
L01 : 198 DINING ROOM	-	126	-	75
L01 : ENSUITE 38	-	97	-	28
L01 : ENSUITE 37	-	97	-	29
L01 : READING ROOM 05	90	-	-	85
L01 : 0.035 BROOM CPBD	124	-	-	6
L01 : 0.034 BROOM CPBD	124	-	-	6
L01 : 217 LINEN STORE	124	-	-	12
L01 : READING ROOM 06	90	-	-	107
L01 : LINEN STORE 216	124	-	-	12
L01 : ENSUITE 46	-	97	-	29
L01 : ENSUITE 47	-	97	-	29
L01 : ASISTED BATH 101	-	126	-	65
L01 : COMMERCIAL KITCHEN	-	138	-	58
L01 : COMMERCIAL KITCHEN	-	138	-	45
L01 : ENSUITE 48	-	97	-	28
L01 : 182 STAFF ROOM	137	-	-	61
L01 : 108 SERVICE LOBBY	-	88	-	49
L01 : ENSUITE 34	-	97	-	29
L01 : ENSUITE 35	-	97	-	29
L01 : STAIRCASE 01	-	88	-	137
L01 : STAIRCASE 02	-	88	-	127
L01 : ENSUITE 45	-	97	-	28

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L01 : ENSUITE 36	-	97	-	28
L01 : 110 TREATMENT ROOM	-	90	-	144
L01 : 141 CLINICAL ROOM	-	90	-	83
L01 : COMMERCIAL KITCHEN	-	138	-	145
L01 : 182 STAFF ROOM	137	-	-	83
L01 : 215 E LEARNING	90	-	-	44
L01 : LOBBY 213	-	88	-	68
L01 : 125 ASSISTED WC	-	90	-	30
L01 : 212 ROOF ACCESS	-	88	-	37
L01 : 196 DINING ROOM	-	126	-	75
L01 : ENSUITE 39	-	97	-	29
L01 : ENSUITE 40	-	97	-	26
L01 : ENSUITE 33	-	97	-	31
L01 : CLINICAL ROOM	-	90	-	103
L01 : CARE OFFICE	92	-	-	90
L01 : 176 MAIN STAIRCASE	-	88	-	46
L01 : 176 MAIN STAIRCASE	-	88	-	68
L01 : 105 CLEANERS STORE	124	-	-	20
L01 : 104 SLUICE	-	126	-	27
L01 : ENSUITE 59	-	97	-	28
L01 : ENSUITE 60	-	97	-	29
L01 : ENSUITE 58	-	97	-	29
L01 : ENSUITE 57	-	97	-	32
L01 : ENSUITE 61	-	97	-	28
L01 : STAIRCASE 04	-	88	-	113
L01 : LINEN STORE 218	124	-	-	13
L01 : ENSUITE 63	-	97	-	28
L01 : ENSUITE 64	-	97	-	29
L01 : ENSUITE 49	-	97	-	28
L01 : ENSUITE 50	-	97	-	28
L01 : ENSUITE 51	-	97	-	28
L01 : ENSUITE 52	-	97	-	29
L01 : ENSUITE 54	-	97	-	25
L01 : ENSUITE 55	-	97	-	27
L01 : ENSUITE 56	-	97	-	30
L01 : LINEN STORE 219	124	-	-	12
L01 : 190 STAIRCASE	-	88	-	103
L01 : ASSISTED BATH 138	-	126	-	39
L01 : ASSISTED BATH 138	-	126	-	32
L01 : ENSUITE 62	-	97	-	28
L01 : 129 LINEN STORE	124	-	-	13
L00 : 051 ENSUITE 05	-	97	-	32
L00 : 050 BEDROOM 05	-	92	-	48

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L00 : 052 BEDROOM 06	-	92	-	48
L00 : 053 ENSUITE 06	-	97	-	31
L00 : 055 ENSUITE 07	-	97	-	32
L00 : 054 BEDROOM 07	-	92	-	46
L00 : 056 BEDROOM 08	-	92	-	44
L00 : 057 ENSUITE 08	-	97	-	29
L00 : 031 HOUSEHOLD LOUGE 01	-	126	-	71
L00 : 034 BROOM CPBD	124	-	-	6
L00 : 035 BROOM CPBD	124	-	-	6
L00 : 026 SEATING AREA	-	126	-	13
L00 : 032 DINING ROOM	-	126	-	80
L00 : 033 SERVERY	-	90	-	53
L00 : 036 DINING ROOM	-	126	-	80
L00: 078 ENSUITE 09	-	97	-	29
L00: 076 ENSUITE 10	-	97	-	32
L00: 074 ENSUITE 11	-	97	-	31
L00: 072 ENSUITE 12	-	97	-	32
L00: 069 ENSUITE 13	-	97	-	31
L00 : 66 HOIST LINEN STORE 02	124	-	-	14
L00: 065 ENSUITE 14	-	97	-	32
L00: 063 ENSUITE 15	-	97	-	32
L00: 061 ENSUITE 16	-	97	-	31
L00 : 058 ASSISTED BATH	-	126	-	45
L00 : 058 ASSISTED BATH	-	126	-	37
L00 : 028 SLUICE	-	126	-	30
L00 : 027 CLEANERS LINEN STORE	124	-	-	23
L00 : 022 MAIN STAIRCASE	-	88	-	79
L00 : 021 STAIR	-	88	-	56
L00 : 016 SHOP AND TEA ROOM	-	126	-	88
L00 : 009 LOUNGE	-	126	-	75
L00 : 012 HAIR SALON	-	137	-	108
L00 : 082 CARE OFFICE	92	-	-	98
L00 : 048 ENSUITE 04	-	97	-	31
L00 : O45 HOIST LINEN STORE 01	124	-	-	14
L00 : 044 ENSUITE 03	-	97	-	32
L00 : 042 ENSUITE 02	-	97	-	32
L00 : 040 ENSUITE 01	-	97	-	34
L00 : 025 CLINICAL ROOM	-	90	-	110
L00 : 024 CARE OFFICE	92	-	-	96
L00 : 029 ASSISTED WC	-	90	-	33
L00 : 018 STORE	124	-	-	11
L00 : 020 CLEAN LAUNDRY LAUNDRETTE	-	108	-	130
L00 : 017 SERVICE CORRIDOR	-	124	-	42

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L00 : 004 ADMIN OFFICE	92	-	-	67
L00 : 003 MANAGERS OFFICE	92	-	-	92
L00 : 010 ASSISTED WC	-	90	-	33
L00 : 088 SERVERY	-	90	-	42
L00 : 091 STORE ROOM	124	-	-	14
L00 : 095 PLANT ROOM	115	-	-	159
L00 : 092 ASSISTED BATHROOM	-	126	-	35
L00 : 092 ASSISTED BATHROOM	-	126	-	45
L00 : 099 ENSUITE 32	-	97	-	32
L00 : 098 BEDROOM 32	-	92	-	50
L00 : 100 BEDROOM 31	-	92	-	47
L00 : 101 ENSUITE 31	-	97	-	31
L00 : 103 ENSUITE 30	-	97	-	31
L00 : 104 HOIST LINENSTORE 04	124	-	-	14
L00 : 105 STAIRCASE 04	-	88	-	127
L00 : 106 BEDROOM 29	-	92	-	45
L00 : 107 ENSUITE 29	-	97	-	31
L00 :111 BEDROOM 28	-	92	-	44
L00 :110 ENSUITE 28	-	97	-	31
L00 :111 BEDROOM 27	-	92	-	51
L00 : 112 ENSUITE 27	-	97	-	31
L00 : 113 BEDROOM 26	-	92	-	47
L00 : 114 ENSUITE 26	-	97	-	32
L00 : 115 BEDROOM 25	-	92	-	45
L00 : 116 ENSUITE 25	-	97	-	35
L00 : 090 HOUSEHOLD LOUNGE 04	-	126	-	43
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	104
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	117
L00 : 007 DOC M WC	-	90	-	29
L00 : 011 COMMS. ROOM	130	-	-	55
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	102
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	104
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	206
L00: 125 BEDROOM 21	-	92	-	46
L00 : 128 STAIRCASE 03	-	88	-	115
L00 : 127 HOIST LINENSTORE 03	124	-	-	14
L00: 130 ENSUITE 20	-	97	-	32
L00: 132 ENSUITE 19	-	97	-	31
L00: 133 BEDROOM 18	-	92	-	46
L00: 135 BEDROOM 17	-	92	-	44
L00: 136 ENSUITE 17	-	97	-	31
L00 : 085 ASSISTED WC	-	90	-	37
L00 : 082 CARE OFFICE	92	-	-	90

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L00 : 124 READINGROOM 03	90	-	-	101
L00: 122 BEDROOM 22	-	92	-	48
L00: 123 ENSUITE 22	-	97	-	28
L00: 121 ENSUITE 23	-	97	-	30
L00: 120 BEDROOM 23	-	92	-	48
L00: 118 BEDROOM 24	-	92	-	47
L00: 119 ENSUITE 24	-	97	-	33
L00 : 087 HOUSEHOLD LOUNGE 03	-	126	-	64
L00 : 086 DINING ROOM	-	126	-	62
L00 : 023 HOUSEHOLD CORRIDOR	-	124	-	112
L00: 129 BEDROOM 20	-	92	-	49
L00: 131 BEDROOM 19	-	92	-	49
L00: 060 BEDROOM 16	-	92	-	52
L00 : 070 READING ROOM	90	-	-	148
L00: 064 BEDROOM 14	-	92	-	46
L00: 068 BEDROOM 13	-	92	-	47
L00 : 067 STAIRCASE 02	-	88	-	124
L00: 062 BEDROOM 15	-	92	-	46
L00: 071 BEDROOM 12	-	92	-	48
L00: 073 BEDROOM 11	-	92	-	48
L00: 077 BEDROOM 09	-	92	-	42
L00: 075 BEDROOM 10	-	92	-	46
L00 : 037 HOUSEHOLD LOUNGE 02	-	126	-	49
L00 : 049 READINGROOM	90	-	-	147
L00 : 039 BEDROOM 01	-	92	-	55
L00 : 041 BEDROOM 02	-	92	-	46
L00 : 043 BEDROOM 03	-	92	-	48
L00 : 046 STAIRCASE 01	-	88	-	138
L00 : 047 BEDROOM 04	-	92	-	47
L00 : 019 DIRTY LAUNDRY	-	108	-	137
L00 : 084 SLUICE	-	126	-	31
L00 : 108 READING ROOM 04	90	-	-	119
L01 : 139 SLUICE	-	126	-	29
L01 : 140 CARE OFFICE	92	-	-	85
L01 : 141 CLINICAL ROOM	-	90	-	30
L01 : 116 ASSISTED WC	-	90	-	34
L00 : 108 READING ROOM 04	90	-	-	95
L00 : 001 DRAFT LOBBY	-	88	-	139
L00 : 002 FOYER	-	137	22	279
L00 : 124 READINGROOM 03	90	-	-	94
L01 : BEDROOM 44	-	92	-	45
L01 : BEDROOM 43	-	92	-	46
L01 : BEDROOM 42	-	92	-	54

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L01 : BEDROOM 41	-	92	-	50
L01 : BEDROOM 40	-	92	-	42
L01 : BEDROOM 39	-	92	-	45
L01 : BEDROOM 38	-	92	-	47
L01 : BEDROOM 37	-	92	-	46
L01 : BEDROOM 45	-	92	-	44
L01 : BEDROOM 46	-	92	-	43
L01 : BEDROOM 47	-	92	-	44
L01 : BEDROOM 48	-	92	-	58
L01 : BEDROOM 33	-	92	-	52
L01 : BEDROOM 34	-	92	-	53
L01 : BEDROOM 35	-	92	-	54
L01 : BEDROOM 36	-	92	-	45
L01 : BEDROOM 49	-	92	-	43
L01 : BEDROOM 50	-	92	-	44
L01 : BEDROOM 51	-	92	-	47
L01 : BEDROOM 52	-	92	-	48
L01 : BEDROOM 53	-	92	-	44
L01 : BEDROOM 54	-	92	-	46
L01 : BEDROOM 55	-	92	-	47
L01 : BEDROOM 56	-	92	-	45
L01 : BEDROOM 57	-	92	-	43
L01 : BEDROOM 58	-	92	-	45
L01 : BEDROOM 59	-	92	-	49
L01 : BEDROOM 60	-	92	-	43
L01 : BEDROOM 61	-	92	-	43
L01 : BEDROOM 62	-	92	-	46
L01 : BEDROOM 63	-	92	-	45
L01 : BEDROOM 64	-	92	-	48
L01 : 169 HOUSEHOLD CORRIDOR 08	-	124	-	104
L01 : 147 HOUSEHOLD CORRIDOR 07	-	124	-	112
L01 : 175 CORRIDOR	-	124	-	123
L01 : HOUSEHOLD CORRIDOR 06	-	124	-	104
L01 : 200 CORRIDOR	-	124	-	103
L01 : HOUSEHOLD CORRIDOR 05	-	124	-	102
L01 : 170 HOUSEHOLD LOUNGE	-	126	-	70
L01 : 0.026 SEATING AREA	-	126	-	13
L01 : 199 HOUSEHOLD LOUNGE 199	-	126	-	70
L01 : TERRACE LOUNGE 173	-	126	-	46
L01 : HOUSEHOLD LOUNGE 167	-	126	-	64
L01 : 168 HOUSEHOLD LOUNGE	-	126	-	65
L00 : ENSUITE 18	-	90	-	31
L01 : 0.079 CORRIDOR	-	124	-	117

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L00 : 102 BEDROOM 30	-	92	-	48
L01 :	-	90	-	46
L01 : 0.088 SERVERY	-	90	-	40
L01 : 172 STORE	124	-	-	13
L01 : DINING ROOM 0.086	-	126	-	59
L01 : 186 F WC	-	90	-	20
L01 : 185 F WC	-	90	-	20
L01 : 126 STAFF SHOWER	-	90	-	7
L01 : 209 STAFF SHOWER	-	90	-	12
L01 : 210 STAFF SHOWER	-	90	-	8
L01 : 211 STAFF CHANGING	-	90	-	60
L01 : 128 M WC	-	90	-	13
L00 : 089 DINING ROOM	-	126	-	98

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01 : 197 SERVERY	NO (-70.5%)	NO
L01 : READING ROOM 05	NO (-73.8%)	NO
L01 : READING ROOM 06	NO (-66.3%)	NO
L01 : COMMERCIAL KITCHEN	N/A	N/A
L01 : COMMERCIAL KITCHEN	N/A	N/A
L01 : 182 STAFF ROOM	N/A	N/A
L01 : 110 TREATMENT ROOM	NO (-88.4%)	NO
L01 : 141 CLINICAL ROOM	NO (-69.6%)	NO
L01 : COMMERCIAL KITCHEN	NO (-90.9%)	NO
L01 : 182 STAFF ROOM	NO (-81.4%)	NO
L01 : 215 E LEARNING	N/A	N/A
L01 : CLINICAL ROOM	N/A	N/A
L01 : CARE OFFICE	N/A	N/A
L01 : 104 SLUICE	N/A	N/A
L00 : 050 BEDROOM 05	NO (-80.6%)	NO
L00 : 052 BEDROOM 06	NO (-77.8%)	NO
L00 : 054 BEDROOM 07	NO (-41.3%)	NO
L00 : 056 BEDROOM 08	NO (-53.1%)	NO
L00 : 031 HOUSEHOLD LOUGE 01	NO (-45.7%)	NO
L00 : 026 SEATING AREA	N/A	N/A
L00 : 033 SERVERY	NO (-68.5%)	NO
L00 : 028 SLUICE	N/A	N/A
L00 : 016 SHOP AND TEA ROOM	NO (-72.8%)	NO
L00 : 009 LOUNGE	NO (-17.2%)	NO
L00 : 012 HAIR SALON	NO (-73.9%)	NO
L00 : 082 CARE OFFICE	NO (-63.5%)	NO
L00 : 025 CLINICAL ROOM	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L00 : 024 CARE OFFICE	N/A	N/A
L00 : 004 ADMIN OFFICE	NO (-67.5%)	NO
L00 : 003 MANAGERS OFFICE	NO (-64.5%)	NO
L00 : 088 SERVERY	NO (-92.3%)	NO
L00 : 098 BEDROOM 32	NO (-73.5%)	NO
L00 : 100 BEDROOM 31	NO (-60.5%)	NO
L00 : 106 BEDROOM 29	NO (-78.5%)	NO
L00 :111 BEDROOM 28	NO (-72.4%)	NO
L00 :111 BEDROOM 27	NO (-42.1%)	NO
L00 : 113 BEDROOM 26	NO (-37.3%)	NO
L00 : 115 BEDROOM 25	NO (-49.3%)	NO
L00 : 090 HOUSEHOLD LOUNGE 04	NO (-53.3%)	NO
L00: 125 BEDROOM 21	NO (-69.1%)	NO
L00: 133 BEDROOM 18	NO (-38.6%)	NO
L00: 135 BEDROOM 17	NO (-62.7%)	NO
L00 : 082 CARE OFFICE	N/A	N/A
L00 : 124 READINGROOM 03	NO (-72.2%)	NO
L00: 122 BEDROOM 22	NO (-68.6%)	NO
L00: 120 BEDROOM 23	NO (-38.4%)	NO
L00: 118 BEDROOM 24	NO (-53.7%)	NO
L00 : 087 HOUSEHOLD LOUNGE 03	NO (-53.4%)	NO
L00: 129 BEDROOM 20	NO (-51.3%)	NO
L00: 131 BEDROOM 19	NO (-43.9%)	NO
L00: 060 BEDROOM 16	NO (-60.5%)	NO
L00 : 070 READING ROOM	NO (-77.5%)	NO
L00: 064 BEDROOM 14	NO (-44.1%)	NO
L00: 068 BEDROOM 13	NO (-64.3%)	NO
L00: 062 BEDROOM 15	NO (-36.4%)	NO
L00: 071 BEDROOM 12	NO (-71.4%)	NO
L00: 073 BEDROOM 11	NO (-48.9%)	NO
L00: 077 BEDROOM 09	NO (-31%)	NO
L00: 075 BEDROOM 10	NO (-42.3%)	NO
L00 : 037 HOUSEHOLD LOUNGE 02	NO (-49%)	NO
L00 : 049 READINGROOM	NO (-83.4%)	NO
L00 : 039 BEDROOM 01	NO (-51.3%)	NO
L00 : 041 BEDROOM 02	NO (-33.5%)	NO
L00 : 043 BEDROOM 03	NO (-29.4%)	NO
L00 : 047 BEDROOM 04	NO (-59.1%)	NO
L00 : 084 SLUICE	NO (-85.2%)	NO
L00 : 108 READING ROOM 04	NO (-80.8%)	NO
L01 : 139 SLUICE	NO (-83.4%)	NO
L01 : 140 CARE OFFICE	N/A	N/A
L01 : 141 CLINICAL ROOM	NO (-88.4%)	NO
L00 : 108 READING ROOM 04	NO (-61.6%)	NO
L00 : 002 FOYER	N/A	N/A
L00 : 124 READINGROOM 03	NO (-75.2%)	NO
L01 : BEDROOM 44	NO (-81%)	NO
L01 : BEDROOM 43	NO (-64.6%)	NO
L01 : BEDROOM 42	NO (-58.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L01 : BEDROOM 41	NO (-56%)	NO
L01 : BEDROOM 40	NO (-69.5%)	NO
L01 : BEDROOM 39	NO (-60.1%)	NO
L01 : BEDROOM 38	NO (-66.2%)	NO
L01 : BEDROOM 37	NO (-84.1%)	NO
L01 : BEDROOM 45	NO (-81.1%)	NO
L01 : BEDROOM 46	NO (-60.8%)	NO
L01 : BEDROOM 47	NO (-51.3%)	NO
L01 : BEDROOM 48	NO (-76.5%)	NO
L01 : BEDROOM 33	NO (-71.6%)	NO
L01 : BEDROOM 34	NO (-47.7%)	NO
L01 : BEDROOM 35	NO (-47.1%)	NO
L01 : BEDROOM 36	NO (-79.6%)	NO
L01 : BEDROOM 49	NO (-73.2%)	NO
L01 : BEDROOM 50	NO (-54.7%)	NO
L01 : BEDROOM 51	NO (-60.2%)	NO
L01 : BEDROOM 52	NO (-66%)	NO
L01 : BEDROOM 53	NO (-83.3%)	NO
L01 : BEDROOM 54	NO (-83%)	NO
L01 : BEDROOM 55	NO (-57.3%)	NO
L01 : BEDROOM 56	NO (-68.8%)	NO
L01 : BEDROOM 57	NO (-65.6%)	NO
L01 : BEDROOM 58	NO (-55%)	NO
L01 : BEDROOM 59	NO (-61.4%)	NO
L01 : BEDROOM 60	NO (-81.6%)	NO
L01 : BEDROOM 61	NO (-87.9%)	NO
L01 : BEDROOM 62	NO (-74%)	NO
L01 : BEDROOM 63	NO (-69.7%)	NO
L01 : BEDROOM 64	NO (-85.4%)	NO
L01 : 170 HOUSEHOLD LOUNGE	NO (-34.8%)	NO
L01 : 0.026 SEATING AREA	N/A	N/A
L01 : 199 HOUSEHOLD LOUNGE 199	NO (-46.3%)	NO
L01 : TERRACE LOUNGE 173	NO (-82%)	NO
L01 : HOUSEHOLD LOUNGE 167	NO (-32.2%)	NO
L01 : 168 HOUSEHOLD LOUNGE	NO (-29.1%)	NO
L00 : 102 BEDROOM 30	NO (-63.7%)	NO
L01 : 0.088 SERVERY	NO (-84.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	3785.1	3785.1
External area [m^2]	6243.7	6243.7
Weather	SOU	SOU
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	1490.07	2311.28
Average U-value [W/m^2K]	0.24	0.37
Alpha value* [%]	10.99	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est /Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
89	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
11	**Residential spaces**
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	26.96	33.52
Cooling	4.07	2.55
Auxiliary	8.43	5.05
Lighting	16.95	22.6
Hot water	33.73	34.41
Equipment*	49.64	49.64
TOTAL**	**90.15**	**98.13**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	6.12	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	117.46	142.5
Primary energy* [kWh/m^2]	318.91	277.68
Total emissions [kg/m^2]	40.4	40.5

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	112.2	0	38.9	0	0	0.8	0	1	0
	Notional	149.2	0	48.1	0	0	0.86	0	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	3.7	0	1.3	0	4	0.8	0	1	0
	Notional	11.1	0	3.6	0	5	0.86	0	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	1.1	0	0.4	0	11.8	0.8	0	1	0
	Notional	3.3	0	1.1	0	5.2	0.86	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	0.7	1635.7	0.1	182.8	275.9	3.49	2.49	3.75	3.5
	Notional	0	1731.2	0	126.9	173.2	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	46.9	69.1	3.7	7.7	3.3	3.49	2.49	3.75	3.5
	Notional	58.3	33.5	6.3	2.5	2	2.56	3.79	----	----
[ST] Other local room heater - unfanned, [HS] Direct or storage electric heater, [HFT] Electricity, [CFT] Electricity										
	Actual	185.3	0	64.3	0	18.7	0.8	0	1	0
	Notional	228.3	0	73.6	0	18.9	0.86	0	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.15	L0000055:Surf[1]
Floor	0.2	0.17	L0000060:Surf[8]
Roof	0.15	0.17	L0000055:Surf[0]
Windows, roof windows, and rooflights	1.5	1.12	L0000070:Surf[5]
Personnel doors	1.5	1.1	L0000136:Surf[2]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3

Section M1

Domestic Water Services

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M1-1 GENERAL REQUIREMENTS

The domestic hot and cold water services shall serve all sanitary ware and other outlets.

Mains cold water shall be fed to a cold water tank and then boosted via pump sets to the required pressure for distribution to all outlets.

Hot water shall be generated centrally at the central calorifiers. To ensure that hot water is supplied quickly to all outlets the hot water system shall be a recirculating system with return pump.

Thermostatic mixing valves shall be provided throughout the project except for the laundry, cleaners and main catering kitchen sinks. Domestic sinks within residential areas shall be provided with a TMV.

All sanitary ware shall be supplied by the Main Contractor but shall be piped up by the 'Water Safe' certified Mechanical Contractor. The entire installation shall be fully in accordance with best practice to minimise the risks of legionella bacteria growth in accordance with the industry 'Standards Applicable' listed below.

On completion the whole installation shall be flushed and sterilised.

M1-2 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS			
BCWS	Boosted Cold Water Service	PHX / PHE	Plate Heat Exchangers
DRV	Double Regulating Valve	TCV	Thermal Circulation Valve
HIU	Heat Interface Unit	TMV	Thermostatic Mixing Valve
HWSF	Hot Water Service Flow	WRAS	Water Regulation Advisory Scheme
HWSR	Hot Water Service Return	VFC	Volt Free Contacts
MCWS	Mains Cold Water Service		

M1-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred pipework material and standard or utilise one of the alternative materials and standards of construction listed in the 'General Installation Standards' sections detailed earlier in this specification. Agreed alternative materials for the installation from the preferred standard material and standard of construction are:

No deviation from the 'General Installation Standards' section preferred material and jointing method requirements.

'General Installation Standards' Sections provides all necessary details on pipework and valve materials and performance requirements that apply to this section.

Domestic sprinkler system shall be installed where required to be both fire rated and WRAS approved using CPVC 'Blazemaster' or stainless steelwork pipework and fittings. This is a departure from 'General Installation Standards'. The entire installation shall be carried out and tested fully in accordance with the product manufacturer's best practice recommendations.

M1-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BESA Standards	BS 1710 Identification of pipelines and services
BS 6068 Water quality	BS 6920 Suitability of non-metallic materials and products for use with water intended for human consumption
BS 7671 Requirements for electrical installations. IET Wiring Regulations	BS 8558 Design, installation, testing and maintenance of water for domestic use
BS 9251 Fire sprinkler systems for domestic and residential occupancy – Code of practice	BS EN 806 Water for human consumption
BS EN 1057 Copper tubes	BS EN 1254 Plumbing Fittings
BS EN 1287 Thermostatic mixing valves	BS EN 12236 Hangers and Supports
BSRIA Standards and Commissioning Codes	Building Regulations, particularly Approved Document Part G
CIBSE Commissioning Codes	CIBSE Guides, particularly Guide G Public Health and Plumbing
Commission Delegated Regulation EU No. 811/2013	HBNs

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STANDARDS	
HSE ACOP L8 The control of legionella bacteria in water systems	HSG 274 Part 2 hot and cold water systems
HTMs, particularly HTM 04-01	NHS D08 TMV3 Thermostatic mixing valves
PD 855468 Flushing and disinfection of domestic water	Pressure Equipment Regulations & amendments

HEALTHCARE STANDARDS	
All relevant NHS Health Building Notes (HBNs) and Health Technical Memoranda (HTMs)	
Health Technical Memorandum (HTM) 04-01 Safe water in healthcare premises. Part A: Design, installation and commissioning	Health Technical Memorandum 04-01: Safe water in healthcare premises. Part B: Operational management

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M1-5 SCOPE OF WORKS

The following brief description lists those systems required for installation on this project. Comprehensive system requirements shall be detailed in the subsequent clauses of this specification together with schematic and design drawings.

The domestic hot and cold water services installation shall include for all necessary tools, labour, materials and equipment to supply, install, commission and put into operation the domestic water services, including the following:

1) Incoming mains cold water services from new supply from utility company in the road.
2) Mains pressure potable quality hot and cold water services to all sanitary ware outlets.
3) Mains fed combined potable and domestic sprinkler cold water tanks and booster sets.
4) Non-potable category 5 backflow prevention tank and booster set to serve refuse wash down bib taps, etc.
5) Potable boosted cold water distribution system to all sanitary ware.
6) All necessary domestic water pipework, fittings, valves, brackets and fixings.
7) All necessary trace heating systems to external sections of pipework.
8) All witnessed hydraulic pressure tests, balancing, venting and commissioning.
9) All sterilisation, flushing, filling and venting of all services to be potable quality.
10) All laboratory testing to prove water quality is fit for its designated purpose as listed.
11) All thermal insulation in compliance with the earlier section of this specification, including vapour sealing.
12) Liaison with other trades on site.
13) All primary and secondary support systems to install the services.
14) Water use meters.
15) Design development and coordination of the tender information to fully detailed working or installation drawings. This shall include responsibility for the following areas:-
    a) Support systems/brackets for all services.
    b) Expansion and contraction within the system networks.
    c) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.
    d) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents.
    e) Development of the controls specification for the hardware, software, power, controls wiring and all associated equipment.

M1-6 SYSTEM PRESSURE RATING

The entire installation including all valves and equipment shall be pressure rated to PN10. All valves and components shall be certified by the manufacturer and stamped as PN10.

This requirement ensures that the system as a whole uses components, valves and fittings that have a common standard pressure rating.

This requirement applies to both mains cold water and boosted cold water systems.

M1-7 INCOMING MAINS COLD WATER SUPPLY

Incoming water supply is detailed in the external works section of this specification. Incoming mains cold water service shall be provided with water meter at building entry.

At entry into the building an injection point shall be provided to allow for the effective sterilisation of the whole installation and sampling of the incoming water supply.

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After the final connection of the incoming water supply is completed and fully flushed but prior to the water supply being fed into the new pipework installation a water sample shall be taken and this sample shall be fully tested to confirm the incoming water is fully potable.

M1-8 INCOMING MAINS COLD WATER METERS

Incoming water supply meters are detailed in the Energy Metering section of this specification.

M1-9 COLD WATER TANKS

Each tank shall be fully compliant with the technical requirements detailed in the schedule at the end of this section and:

1) Be fully potable quality.
2) Shall be piped up to operate in parallel flow with equal flow rate through and turnover of water through each tank.
3) Fully in accordance with Water Regulation Advisory Scheme (WRAS) guidance and WRAS approved.
4) Be elevated to ensure that the fully capacity of the tank(s) can be used to provide sufficient flooded suction into the booster pump set. It shall not be acceptable that some of the effective capacity of the tank is reduced due the tank level not being high enough to ensure sufficient net positive suction head to the booster set.

   For tender purposes, the tank shall be located on a tank support platform of sufficient height to ensure the tanks are raised to calculated height Tank support shall be a galvanised after manufacture welded steel frame or brick/block piers supporting I-section beams. The final support solution shall be provided with two layers of 25mm thick marine plywood to provide a flat level surface for the tank.

   All secondary steelwork supports to be submitted to the Structural Engineer prior to fabrication for their approval.
5) Where the capacity of the cold water storage exceeds 1,000 litres the tank shall either be provided with a splitter so there are effectively two separate tanks or multiple separate tanks shall be provided all as detailed on the tender domestic water schematic.
6) The tank shall be complete with a bolted heavy duty lid, with screened vent, such that each tank shall be fully suitable for the storage of potable quality water.
7) The tank shall be complete with all necessary pipework connections as detailed below:
   a) Mains water inlet for the filling / ball valve.
   b) Internally flanged tank with base suitable for standing on tank platforms. Designed to allow bottom drain valves to completely empty all sections for maintenance.
   c) All nuts, bolts and washers required to assemble the tank shall be stainless steel.
   d) Screened overflow connections, for each section of the tank, piped to local drain.
   e) Screened warning pipe connections, for each section of the tank, piped to 'visible' agreed location.
   f) Outlet connections, for each section of the tank.
   g) Detector mounted in middle of side of each tank to measure water temperature (gauge or BMS), for each section of the tank.
   h) Dump valve piped to discharge to drain.
   i) Future allowance for two new pipework connections on opposite sides of the tank for cooling water circuit to be added, if desired. Future connections shall be pass through tank connectors to allow the future cooling water to be a separate hydraulic cooling circuit to the store water if desired.
   j) The overflow and warning pipes shall be fitted with Norscreen insect screen by Technron Equipment Limited.
   k) Each tank shall be provided with the connections to suit the sizes and arrangements of pipework indicated on the drawing and shall terminate with pipework flanges for all pipes. Connections for thermometers and level switches shall be allowed.
8) All panels are to be pre-insulated by the encapsulation of expanded polyurethane foam totally within the plate laminate and shall be moulded with an impervious gel coat surface, a high glass content and shall not contain fillers.
9) The insulation thickness shall be 50mm giving a U value of 0.4 $W/m^2/°C$.
10) Provision shall be made for factory fitted UPVC pads within the panel insulation to aid pipe connections.
11) A sealant strip and mastic film shall be bolted together with STAINLESS STEEL nuts, bolts and washers.
12) A sealed removable hinged manhole shall be provided on the top of the tank. The panels forming the top sections of the tank shall be of the heavy duty type to withstand a man's weight. Ensure adequate access is provided in accordance with the WRAS Water Regulations Guide.
13) Separate warning pipes shall be provided per tank.
14) Warning and overflow pipes shall not be fitted with isolation valves or any flexible connections.
15) Warning pipes shall be at least 19mm internal diameter.
16) Overflow pipes shall be sized to ensure that the discharge rate from the overflow exceeds the maximum possible flow through the filling pipe to the tank. The restriction due to the insect mesh guard shall be taken into account to ensure the peak overflow can be accommodated.
17) Warning pipes shall be laid to fall and routed to conspicuous locations outside the building fully compliance with WRAS Water Regulations Guide.
18) Wherever it is not possible to install a warning pipe to a suitable conspicuous external location a level indicator shall be provided with an audible and visible alarm which operates when the water level reaches 25mm below invert level of the overflow. This alarm shall be hard wired and monitored by the BMS front end and also activate a white flashing Xenon beacon alarmed located in a position agreed with the client prior to installation. Wireless monitoring alarms shall not be permitted.

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19) Overflow pipes shall be laid to fall and terminated via a type AA air gap.

After completion of the erection of the tanks, the tanks shall be filled with water and carefully checked for leaks. The tanks shall then remain filled with water for a period of one week and any joints found leaking made good.

Prior to the manufacture of the storage tanks, forward manufacturing details to the Employers Agent for approval. 2 copies of the manufacturers certified working drawings.

Tank(s) set shall be as manufactured by one of the manufacturers listed in the schedule at the end of this section.

M1-10 DELAYED ACTION BALL VALVES ARRANGEMENT TO TWIN TANKS

As detailed in the schematic, the tanks shall be provided with a single in-line control valve that shall be activated hydraulic by flow through either of the tank ball valves and once the control valve activates both tanks shall be filled simultaneously. The pilot ball valves are only required to activate the control valve so shall have a capacity much reduced from the peak design flow rate.

Provide a Keraflo Aylesbury 'KP' valve kit comprising 2 'KB' height adjustable fully adjustable delayed action ball valves, one for each tank, which shall be fed hydraulically to a line size (peak design flow rated) hydraulic control valve.

The volume of water stored between the ball valve opening and closing shall be full adjustable by adjustment of the active chain length so that both the store volume of water in the tank and the reduced water volume that the valve opens are both fully adjustable.

However, where the tanks are designed to feed the domestic sprinkler system the required minimum volumes or water levels that must be maintained in the tanks for firefighting shall be permanently labelled to prevent accidental uninformed adjustment of the tank low level volumes below the domestic sprinkler requirements. A low level water level alarm shall be provided at the minimum water volume required to meet the domestic sprinkler category classification.

The ball valve shall be selected to suit whether the tank is installed directly into the tank or the raised tank chamber as necessary to achieve the required tank volume.

The ball valve shall be manufactured by Keraflo Limited (Tel. No. 0118 921 9920).

The ball valve shall be fully WRAS certified and shall not be modified in any way from the original design that was WRAS certified.

Pipework from the control valve to the tanks does not need to be pressure rated to the same test pressure as per the rest of the water pipework as this pipework is subject to reduced water pressure so pipework downstream of the control valve may be installed using UPVC Class C potable pipe.

The entire installation shall be fully in accordance with the manufacturer's recommendations with particular attention being drawn to the following specific requirements:

- Balance pipe between the two tanks shall be same diameter as the main pipe to the booster set. All valves in this balance pipe shall be line size with full bore opening when open.
- Take off tee from tanks to the booster set shall be equal length and pressure loss for even drawn down.
- Filling pipes from the in-line control valves to the tanks shall be equal pressure loss (so ideally equal length but if not 100% possible then a line size double regulating valve to each tank shall be required).
- The tanks shall be configured to operate with equal flow through each tank.
- Capacity of the tanks shall be adjustable via the chain linkage adjustment to ensure that the turnover is sufficient to maintain optimum potable water quality.

M1-11 COLD WATER BOOSTER SET

In the position indicated on the drawing, supply, delivery, installation and full commissioning of a potable quality packaged cold water booster set, which shall include pressurisation accumulator, check valves, flexible connections and isolation valves. Where indicated on the schematic the local safety valve shall be piped to a local drain.

Each tank shall be fully compliant with the technical requirements detailed in the schedule at the end of this section and:

1) Fully compliant with Commission Regulations EU No. 547/2012, 640/2009 and 641/2009.
2) The equipment shall be CE certified.
3) Variable speed drive pumps designed to operate in sequence to provide the duty detailed in the schedule. The booster set shall has a standby pump, that is run, assist, standby with as many assist pumps provided as necessary to meet the duty. Pumps shall be selected to provide and operate on a flat pump curve.
4) Each pump shall be complete with a frequency inverter to provide variable control of pump performance. The equipment shall be filtered against the transmission to/from mains borne interference (harmonies) etc.
5) The unit shall be complete with a fully intelligent control system to operate the pumps in sequence, i.e. cascade to suit demand. The controls shall avoid over pressurising at low volumes and reduce the number of stops and starts or respective pumps, via a 'start limit' delay timer.
6) The controls shall include a routine that operates after a loss of electrical power to the booster set. This routine shall ensure that pump start up duty is limited to prevent 'over pressure' shock waves damaging the distribution pipework.
7) Fully integrated packaged control panel, complete with mimic diagram and all necessary controls and all suitable for a 3 phase, 415 50Hz electrical supply, unless advised otherwise in the controls section of this specification.
8) Fully potable quality flexible connections to suction and discharge pipework.
9) All interconnecting pipework within the unit being installed in either lead free copper or plastic and all fully compliant with WRAS Water Regulations.
10) Mounted on a steel base plate and include anti-vibration mounts.
11) Expansion vessel (pressurisation accumulator), as required, to avoid water hammer at very low demand. The expansion vessel must be WRAS approved and be certified to be water circulating 'throughput' design to avoid dead leg and stagnation.

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12) Complete with local electrical isolator interlocked as required.

13) Complete with an additional water level float switches, which shall be hard wired between the water tank(s) and the booster set. These float switches shall prevent the booster set from operations on low water level within the tanks.

14) Irrespective on if a pressure reducing valve is shown on the tender drawings or not a line size pressure reducing valve shall be provided for any booster set designed to supply more than 0.5 litres/second and a discharge pressure of more than 3 BarG, which together with the inverter controlled pumps and expansion vessel, shall help avoid water hammer at minimum demand (one tap open at 6 litres/minute).

15) Pump controls shall automatically start each pump every 30 days as recommended by BAFSA. The automatic start shall be achieved by simulating a loss of system pressure. If any pump fails to start during automatic start testing an alarm shall be raised.

16) Be continuously rated for the design flow rate of the sprinkler system or the potable water use whichever is the greater for the category and operating time required for the sprinkler system.

17) Be hard wired from the Low Voltage panel and not from the local BMS control panel – fully in accordance with BS 9251, specifically clause 5.9 in its entirety. The power supply shall be fused and not fed from MCBs.

Booster set shall be as manufactured by one of the manufacturers listed in the schedule at the end of this section.

M1-12 PRESSURE REDUCING VALVES

In the position(s) indicated on the drawings and as detailed above for cold water booster sets install the pressure reducing valve(s) to reduce the water pressure from elevated mains water pressure to nominally 1.5 BarG (adjustable) per floor.

A safety valve shall not be required after the PRV(s) to relief system pressure should the PRV fail as the PRVs are provided to minimize excessive water consumption by both the sprinkler system and potable water use plus to prevent water hammer. The PRV shall be a fail open type device. An independent pressure gauge shall be installed upstream and downstream of the PRV.

Pressure reducing valve(s) shall be:

1) WRAS certified.

2) Provided with knob adjustable downstream pressure adjustment from 1.5BarG to 12BarG.

3) Provided with either flanged or screwed connections. Compression connections are not acceptable.

4) Designed so adjustable spring is not in contact with the water.

5) Provided with pressure gauges upstream and downstream of the valve.

6) Installed with local isolation valves either side of the pressure reducing valve to allow replacement and servicing without extensive drain down being necessary.

7) Installed fully in accordance with the manufacturer's recommendations, specifically:

   a) Sufficient straight pipe diameters before and after the pressure reducing valve.

   b) Strainer or filter to be installed if not integral part of the pressure reducing valve, although the strainer design must not be a dead leg as defined by ACOP L8 / BS 8558.

   c) Installed so that the pressure gauge can be easily read when standing at floor level.

   d) Installed in the orientation dictated by the manufacturer, typically horizontally.

All pressure reducing valves shall be by the same manufacturer throughout the installation and shall be manufactured by:

1) Pegler Yorkshire Group Limited.

2) Reliance Water Controls (Reliance Worldwide Corporation (UK) Limited).

3) Honeywell (UK Heating Controls) (Honeywell International Inc.).

4) Where pressure reducing valves are provided as part of the electric point of use water heater installation kits they shall be provided by the water heater manufacturer.

Provided by the domestic sprinkler system supplier and fully compliant with the relevant British Standard.

M1-13 PRIORITY DEMAND VALVE(S)

Priority demand valves shall be provided as detailed on the tender drawings and:

1) Fully WRAS approved.

2) Spring operated to fail safe normally closed in case of loss of power or other faults so the sprinkler system available (although the potable water supply is interrupted).

3) Fully compliant with the relevant British Standard.

All priority demand valves shall be by the same manufacturer throughout the installation and shall be manufactured by:

1) GRIFEN sprinkler solutions.

2) The domestic sprinkler specialist responsible for the domestic sprinkler system design.

M1-14 SIMPLEX WATER SOFTENER

Unless the incoming water quality can be confirmed by the Mechanical Contractor as being at least 'moderately soft', the Contractor shall supply, install, put into operation and fully commission a simplex water softening system on the cold feed to the domestic hot water calorifiers.

This shall comprise of a packaged system complete with blending package and shall be timer controlled. The softener shall be of the simplex type and be complete with the following: -

1) Polyethylene lined GRP seamless pressure vessels.

2) 5 cycle control valves complete with electrical timing and staging motors, integrated injector and drain line flow controller.

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3) HDPE 114 kg salt storage tank complete with brine well, safety brine valve, brine line flow controller and suction line.
4) Control panel providing status indications and BMS interfacing.
5) Quality water test set.
6) Cartridge filter.
7) Bypass shut off valves.
8) BMS interface for common alarm.

The packaged plant shall be manufactured by one of the following:

9) Kinetico UK Water Systems
10) Elga

Or equal and approved.

M1-15 STORAGE CALORIFIERS

2 No. calorifiers shall be installed and each shall be fully compliant with the technical requirements detailed in the schedule at the end of this section and shall include:

1) Compliant with Commission Regulation EU No. 811/2013 and certified as energy rating of A or better (i.e. A, A+, A++ or A+++).
2) Temperature control of the DHW secondary circuit is achieved by a control valve to the primary side and variable speed LTHW pumps.
3) The overall support casing shall be manufactured from copper or stainless steel and shall be suitable to accept the insulation proprietary removable insulation jacket that shall insulate all hot surfaces. No carbon steel material shall come into contact with the domestic water.
4) All components shall be WRAS approved.
5) Complete with run/and standby primary pumps.
6) Complete with de-stratification pump. The de-stratification pump shall generally be to the same specification as the DHWS return pump and be arranged to operate for a period of one hour at time of little or no demand, i.e. night time.
7) Complete with pressure relief safety valve and combined temperature and pressure relief safety valve.
8) Complete with automatic anti-vacuum valve, drain valve and automatic air vent valve – all valves shall be per 'General Installation Standards' section of this specification.
9) Complete with top and bottom coils.
10) Complete with 9 kW electric back/top up Immersion with control facility through BMS system.
11) Temperature and pressure gauges.
12) Complete with fully packaged control systems (compatible with BMS).
13) Complete with an unvented water supply kit and expansion vessel.
14) Fully compliant with requirements of Pressure Safety Regulation and Pressure Equipment Regulations especially for provision of inspection access for the annual 'written scheme of examination'.
15) Fully thermally insulated as detailed in 'General Installation Clauses – Thermal Insulation' and shall be fully compliant with the non-domestic building services compliance guide.

Calorifier shall be as manufactured by the manufacturers listed in the schedule at the end of this section.

M1-16 HOT WATER CIRCULATING PUMPS

All circulating pump sets to serve the domestic hot water circuits shall be as detailed in the schedules at the end this section and the following additional requirements:

1) The equipment shall be CE certified.
2) Fully compliant with Energy related Products, in terms of electrical efficiency, when assessed under EU Commission Regulations, to achieve an energy rating of 'A' or better.
3) Line size isolation valve on suction and discharge.
4) Line size check valve on discharge.
5) WRAS approved flexible connections on suction and discharge (if required).
6) All components to be line size with reducers used immediately adjacent to pumps.
7) Pump suction and discharge binder test points.
8) Pump suction and delivery manifolds to be fitted with binder test points.
9) Pump discharge to be fitted with test pocket and thermometer.
10) Each pump motor shall be sized to have a shaft power of not less than the maximum pump absorbed power at any point on its characteristic curve plus a margin of 10%.
11) A flow switch shall be fitted across the pump.
12) The construction characteristics of each pump must comply with the following:
    a) Bronze casing.
    b) Impeller - cast bronze, fully enclosed dynamically balanced stainless steel (316L).
    c) Shaft - stainless steel.
    d) Bearings – sealed for life type.

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e) Shaft seal - Mechanical type with hardened ceramic seal and stainless steel seal ring.

13) Pump shall be provided with union connections between the isolation valves and the pump assembly to allow quick removal.

14) An identical spare hot water circulating pump shall be provided and mounted in the wall adjacent to the installed pump. Spare pump shall be provided with union connections to allow for quick installation.

15) Both the installed and spare pumps shall be fully wired and tested to a MK Commando plug. A wall mounted wall mounted connection per the MK Commando socket shall be provided local to the pump installation to allow the unplugging and replacement of the HWS pump without any electrical qualification requirement.

16) Integral inverter variable speed pump motor for commissioning and variable speed control (if temperature maintaining valves are installed now or in the future).

Hot water circulating pumps shall be as manufactured by one of the manufacturers listed in the schedule at the end of this section.

M1-17 EXPANSION VESSEL(S)

Supply, delivery, installation and commissioning of the expansion vessel(s) as detailed on the tender drawings. All domestic expansion vessels shall be as detailed in the appendix to this section and the following additional requirements:

1) Be fully WRAS approved.

2) Include EPDM type diaphragm.

3) Provided with wall or floor support frame provided by the expansion vessel manufacturer.

4) Pressure rated as stated earlier.

5) All expansion vessels shall be 'flow through' type provided with flow inducing valve arrangement. Smaller expansion vessels shall be a single connection with specific flow through valves as provided for the expansion vessels listed below. Larger expansion vessels shall be provided with two pipe connections for inlet and outlet. Where the required water flow rate exceeds the recommended maximum flow of the expansion vessel the vessel shall be piped into the pipework as normal but a line size double regulating valve shall be piped between inlet and outlet pipes to allow water flow to be shared between the expansion vessel and the DRV bypass (as the expansion vessel flow only needs to sufficient to provide circulation through the vessel to avoid legionella).

6) The manufacturers expansion kit shall be provided for each water heater except the expansion vessels shall not be the type supplied by the manufacturer. Suitable flow through expansion vessels are as manufactured by:

a) Flamco Airfix type D vessels.

b) Reflex DD vessels.

M1-18 THERMOSTATIC MIXING VALVES

Supply, install and commission pressure balanced mixing valves to provide a blended temperature of no greater than 41°C for to all hot water outlets only using a Buildcert certified and approved TMV 3 thermostatic mixing valve, with the exception of cleaner's, laundry and main catering kitchen sinks which shall not be thermostatically blended.

Each of the mixing valves shall be provided with a line size isolation valve, strainer and double check valve to each port. All thermostatic mixing valves shall be provided with 3 local isolation valves so that the TMV can be isolated and removed and mains cold water is still available to the sanitary ware.

All domestic water services thermostatic mixing valves (TMV's) shall be:

1) Chrome finish when exposed to view.

2) Fully compliant with Buildcert TMV3 requirements and certified to this effect (at 41°C).

3) Complete with double check valves and strainer on each inlet (to meet current water regulations), either partially built into the valve body or installed in the adjacent hot and cold water supplies to the TMV.

4) In the case of TMV's with integral single NRV's, where required by water regulations an additional NRV shall be fitted.

5) Complete with Ballofix isolation valves on each inlet in order to facilitate maintenance of the TMV, NRV's and strainers.

6) Listed in the current Water Fittings and Materials Directory published by the Water Research Advisory Service (WRAS).

7) Have a maximum outlet flow temperature of 41°C except for bidets which shall be 37°C maximum.

8) These temperatures, either works or site set, must be verified and recorded during site testing and commissioning.

9) Suitable for a minimum maintained pressure of 0.1 bar and up to 6 bar with inlet water temperatures between 10°C and 72°C

10) Adjustable flow temperature between 37°C to 46°C while maintaining thermostatic mixing properties and water shut off in case of cold isolation (although it is accepted the shut off period will not be TMV 3 compliant).

All thermostatic mixing valves shall be as manufactured by Horne Engineering Limited and their model Horne 15.

All mixers shall be sized for correct flow rate at available system pressure drop and shall be of the built-in pipe with fully concealed pipework.

All thermostatic mixing valves shall be commissioned by the commissioning engineer as part of the overall domestic water commissioning process. All thermostatic mixing valve commissioning shall be fully documented and witnessed.

All unblended outlets at 50°C or greater than shall be provided with "Danger – Very Hot Water" labels (as per photo below). The dimensions of the labels shall be 100mm long x 45mm high.

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M1-19 PIPEWORK, VALVES AND FITTINGS

All pipework, valves, fittings and their installation shall be as detailed in 'General Installation Standards – Pipework', deviated from only as detailed earlier in this specification section and as additionally detailed below in the following sub-clauses.

M1-19-1 SECONDARY SUPPORTS

All secondary support steel work for supporting services shall be provided by the Mechanical Contractor. For tender secondary supports are all supports that are required to support the mechanical services that are required over and above those shown on the structural drawings.

M1-19-2 FINAL CONNECTIONS TO SANITARY WARE

The Mechanical Contractor shall allow for making final connections to all sanitary ware and water consuming equipment. The Mechanical Contractor shall allow to pressure test and chlorinate all installed pipework upon the final completion of all installed work in accordance with the 'General Installations Standards – Pipework' section of this specification.

Each item of sanitary ware shall have a local and individual means of isolation, which shall be a combined quarter turn ball isolating and automatic flow restricting valve. These valves shall be as manufactured by Arrow Valves, their model AFL range. These valves are available with a variety of different cartridges to suit different sanitary ware; specific requirements are:

1) Wash Hand Basins shall be fitted with flow restricting cartridges to limit the peak flow rate to 6 litres / minute.
2) Sinks shall be fitted with flow restricting cartridges to limit the peak flow rate to 7 litres / minute.
3) Showers shall not be fitted with flow restricting cartridges (if the shower hose flow restricting limiters are fitted) but if not then the hot and cold water connections shall each be limited to 8 litres / minute.
4) WCs shall not be fitted with flow restricting valves but shall instead be fitted with strainers as is required for all compact WC float valves under WRAS Regulation Guidance and Recommendation reference 25.6.

The flow rates are preliminary for tender purposes and the design engineer shall allow for liaising with the design team and client to agree on the final cartridge selections prior to ordering.

Alternative manufacturers are acceptable provided they provide the same performance and standard criteria as the above valve, this shall include (but not be limited to):

1) Suitable for the maximum water pressure previously specified.
2) Maintain design flow rates between 90 and 110% at all pressures between 1 Bar and maximum specified peak pressure as specified in this specification.
3) Have full WRAS approval.
4) Provided with both strainers and flow restricting cartridges as standard.
5) Suitably temperature rated.
6) Provided with extended spindle lever handles for isolation without any tools (as pipe and valve shall be thermally insulated).
7) Cartridges and strainers can be removed / changed without additional isolation or draining down of the system.

All local isolation, with flow restrictors, strainers or neither, shall be the same manufacturer and model range throughout to maximize ease of servicing and maintaining spares. Mixed manufacturers and model ranges shall not be acceptable.

All final connections to sanitaryware shall be solid pipework connections. The use of flexible braided hoses shall not be acceptable on this project. Any flexible hoses installed on site shall be removed at the cost of the Mechanical Contractor, inclusive of programme implications that result in non-compliance of this clause.

M1-19-3 BACK FLOW PREVENTION

Single and double check valves shall be provided to all necessary branch pipes as required by the current water regulations including:

1) Vending machines shall be a double check valve.
2) Drinking fountains shall be a double check valve.
3) Branches where it is reasonable to assume the services will be infrequently used including kitchens, kitchenettes and showers (these examples are listed in BS8558). Single check valves shall be installed as close to the branch valve as possible.
4) Pressurisation units (unless the feed pipe to the pressurisation unit is looped design in which case check valves shall not be required). Looped cold feed design to pressurisation units is the preferred option that shall be adopted unless technically not possible – cost is not a technical reason for non-compliance. Single check valve shall be installed where a looped design is not installed.
5) HTM compliant thermostatic mixing valves (where single check valves are integrated into the thermostatic mixing valve) shall be installed with additional single check valves to provide double check valves on both hot and cold supplies.
6) All other non-healthcare thermostatic mixing valves to be fitted with single check valves unless the check valves are integrated into the thermostatic mixing valve.
7) Unblended mixer taps – single check valves in hot and cold connections.
8) At entry into buildings – double check valve for all buildings.

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Single and double check valves shall NOT be installed in the following situation:

1) In mains cold water pipes serving ball valves that fill cold water tanks.

M1-19-4 NON-DOMESTIC USE BIB TAPS

For tender and unless agreed in writing from the local water authority all bib taps shall be provided to achieve Category 5 back flow prevention. The water supply shall be provided by a dedicated break tank with type AB air gap.

The taps shall be:

1) Where located externally Arrow Valves, their Conceal-A-Tap units.
2) Where located internally standard hose union bib taps.

A category 5 back flow prevention packaged cold water tank and booster set shall be provided to serve all bib taps. The combined tank and booster set shall be a fully packaged unit shall include:

1) Single run pump.
2) Each pump shall be fully variable speed via inverters.
3) Category 5 back flow prevention – Type AB air gap.
4) Overall performance must be greater than ??? litres per second with a delivered pressure of ?? Bar.

The booster set shall be manufactured by:

- Grundfos, their GTI-E model
- Arrow Valves, their Boost-A-Break model
- AquaTech Pressmain, their MC 5 model

M1-19-5 DRAIN VALVES AND AIR VENTS

Air vents shall not be provided in the domestic hot and cold water system to avoid dead legs and comply with BS 8558. Both hot and cold water connections shall be self-venting, this shall be achieved by providing the branch connections from the top of the pipes at all necessary strategic points to ensure complete venting. Where hot water pipes need to be looped vertically to ensure the dead leg water content remains less than 0.5 litre limit, the design shall be installed with smaller branch connections provided between the vertical loops to ensure the pipes are automatically vented of air through the smaller branch connections.

M1-19-6 COLD WATER DEAD LEGS

Cold water branch pipes shall be limited in length to the following circuits to minimise dead legs and maintain optimum water quality:

1) Branch pipe to water boilers for beverage preparation shall not exceed 300mm long.
2) Branch pipe to water chillers for beverage preparation shall not exceed 300mm long.
3) Branch pipe to drinking fountains shall not exceed 300mm long.
4) Branch pipe to vending machines shall not exceed 300mm long.

M1-19-7 HOT WATER CIRCULATING SYSTEM DEAD LEGS

In accordance with BS8558, the maximum permitted hot water dead legs, including the blended pipework, on the hot water circulating systems shall be limited to 0.5 litre or 3 metres, whichever is the lower value.

For information only, this means that:

1) Where the hot water flow pipe is 22mm diameter after the HWS return connection to sinks, etc the dead leg shall not exceed 1.7 metres.
2) Where the hot water flow pipe is 15mm diameter after the HWS return connection the dead leg shall not exceed 3.0 metres (maximum permitted to meet the 0.5 litre only is 3.4 metre).
3) Where the hot water flow pipe is 22mm after the HWS return connection but reduces to 15mm after a branch the hot water pipe shall be limited to 2 metres (to stay safely within the 0.5 litre volume).

Any singular references to lengths of 3 or 5 metre long hot water dead legs are superseded by this clause as the dead leg limit is a combination of the no more than 0.5 litre and 3 metre limit, whichever is the lower value.

All outlets shall be tested, proven and documented to be compliant with the above requirement by the Commissioning Engineer.

Any non-compliant systems shall be modified to comply by the Mechanical Contractor at their expense and retested until compliance is proven.

M1-20 ELECTRIC WATER BOILERS

Provide water boilers as detailed on the tender drawings, architectural layouts and room data sheets.

All water boilers require to be installed on the project shall be as detailed in the appendix to this section and the following additional requirements:

1) The equipment shall be CE certified.
2) Fully compliant with Energy related Products, in terms of electrical efficiency, when assessed under EU Commission Regulations.
3) Fully WRAS compliant.
4) The water boilers shall be installed in the locations detailed on both the mechanical and architectural tender drawings.
5) Finish as per schedule.
6) Provided with chromed copper pipe vent pipes and chromed copper tundish to deal with water expelled from the water boiler. Tundish shall be as per Zip Water Dispenser Tundish either wall or counter mounted as agreed with the architect or equivalent of similar aesthetic appearance.

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The final location of the water boilers is to be coordinated and agreed with the Architect. Necessary electrical power supplies shall be included as required for tender.

M1-21 WATER FOUNTAINS

Provide water fountains as detailed on the tender drawings, architectural layouts and room data sheets.

Provide drainage and mains cold water connections to all water fountains identified.

The water fountains shall be anti-vandal drinking water dispensers with a 15mm and 19mm outlet.

The fountains shall have a stainless steel basin with a bubbler and push to operate valve.

The fountain housing shall be constructed from stainless steel for ease of cleaning.

All water fountains shall be complete with permanent foul drain and MCWS feeds for a complete installation fully in accordance with the manufacturer's recommendations.

Each 'anti-vandal' fountain shall be as manufactured by one of the following: -

1) Maestro International Limited, their Maestro 56V type
2) Healey and Lord Limited
3) Aquahot Limited

M1-22 THERMAL INSULATION

The whole of the domestic hot and cold water pipework shall be thermally insulated and vapour sealed. All insulation shall be as detailed in 'General Installation Standards – Insulation' section.

M1-23 CHEMICAL DOSING, TESTING AND COMMISSIONING

The system shall be pressure tested, commissioned, chemically dosed and sterilised as described within 'General Installation Standards' sections of this specification.

All water testing necessary to determine what level of treatment is to be provided shall be included within the tender.

The Commissioning Specialist shall complete all commissioning, except equipment shall be commissioned by the equipment manufacturer.

M1-24 FREEZING PROTECTION TRACE HEATING

All pipework at risk of freezing shall be electrically trace heated. Pipework at risk of freezing includes (but is not limited to):

1) External pipework.
2) Pipework routed through unheated spaces, rooms and voids.
3) Buried pipework but where specified buried depth is not achievable.
4) Plant rooms even if provided with back ground heating the cold water pipe shall be trace heated (unless proven not at risk).

The trace heating shall be of the self-regulating type with its heat output varying in response to the surrounding temperature.

The trace heating element shall be applied directly to the pipework beneath the required insulation and associated external weathering finish.

All associated ancillary items including power connection boxes shall be included for the enable a fully functioning trace heating system.

All power feeds to the trace heating control boxes shall be via the mechanical control panel.

The outer casing of all trace heated pipework shall have a vinyl based caution label applied (suitable for external application) identifying that trace heating is installed. The frequency of the labels shall be a maximum of 3m.

Trace heating shall be supplied by Messrs Raychem Ltd or equal and approved.

All electric trace heating installations shall be monitored by the BMS for fault and run signals.

M1-25 EXPANSION AND CONTRACTION

The Mechanical Contractor shall make due allowance within their Tender for expansion and contraction. This shall be in the form of loops, bellows, anchors, guides, offsets, rollers/chairs and cold draw. Wherever feasible natural flexibility solutions shall be employed. All provisions for expansion and contraction shall be indicated on the fabrication drawings submitted with the supporting calculations to the Engineer for comment prior to installation taking place.

In the event when bellows are necessary due to building fabric restraints, multi-layered 316L stainless steel only quality units shall bellows be allowed for at tender. EPDM flexible bellows are not acceptable under any circumstances.

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M1-26 APPENDIX – EQUIPMENT SCHEDULES

COMBINED SPRINKLER AND POTABLE COLD WATER STORAGE TANK	
Quantity	Refer to schematic
Location	Internal Plant Room.
System	General Domestic Sprinkler and Potable Supply
Capacity	TBC - Allow 10,000 litres for tender.
Construction	Internally flanged
Dimensions	As determined by the designer
Connection sizes	As determined by the designer
BMS interfaces	Monitor temperature High level indication Low level indication Monitored Low level alarm to comply with BS 9251
Manufactured by: • Dewey Waters Limited • Balmoral Tanks Limited • Braithwaites Engineers Limited – Water Tanks and Supporting Towers	

PACKAGED DOMESTIC SPRINKLER AND COLD WATER BOOSTER SET	
Quantity	Refer to schematic
Location	Plant room
System	Fully standalone packaged booster set General Potable / Non-Potable Supply to the Laboratories Fully complaint with BS9251 domestic sprinkler and potable WRAS pump set.
Duty	As determined by the designer
Pressure	As determined by the designer
Number of pumps	3 at 50% each – duty, assist and standby.
BMS Interfaces	Enable signal Fault signal Enabled and no fault signal Pressure sensor at discharge from booster set
Power supply	230V 1 phase ???A / 400V 3 phase ???A
Dimensions	As determined by the designer
Manufactured by: • Grundfos Limited • Flow Mech Products Limited • Shieldgard Pumping Technology • Lowara, multi range GV Variable Speed Booster Sets	

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DOMESTIC HOT WATER CALORIFIER	
Quantity	Refer to schematic
Location	Plant room
Primary Fluid	Flow at 66°C Return at 55°C Flow – As determined by the designer Maximum Pressure Drop of 35kPa
Secondary Fluid	In at 10°C Out at 60°C Flow - As determined by the designer Maximum Pressure Drop of 35kPa
Capacity	As determined by the designer – allow min 750 litres storage per calorifier for tender
Recovery time	As determined by the designer
Inner 'wet' surfaces material	All stainless steel / All copper / Copper and glass lined
Outer material	Plastic coated galvanised steel / Plastic
Connections	LTHW F&R CWS inlet HWS outlet HWS return Destratification pump inlet and outlet
BMS Interface	Complete modulating controls to provide constant temperature hot water at variable demand Storage temperature monitoring Enable signal Fault signal Pasteurisation signal Immersion enable and control via BMS.
Expansion vessel	As determined by the designer
Included options	Top and bottom coil, Destratification pump, 9kW Immersion
Manufactured by: • Hamworthy, Hub Powerstack Range • Strebel Heating Technology • Heyco Steel Mantel Plus range	

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DOMESTIC HOT WATER CIRCULATING PUMPS	
Location	Plant Room
Type	In line and WRAS approved
Flow rate	Flow rate and required pressure shall be determined by the Mechanical Contractor. Pump shall be selected to achieve the design flow rate at 70% of maximum speed.
DHWS water	Return between 60ºC and 55°C
Pressure	PN16
Power supply	240Volt / 1Phase / 50Hz
Speed control	Variable speed control via integral inverter control
Maximum Speed	1450 RPM
Include	Wall mounted spare pump.
BMS interfaces	Pump run. Pump fail. Flow fail.
Manufactured by: • Grundfos Pumps • Wilo Pumps • Armstrong Pumps	

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Section M2

Heating

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M2-1 GENERAL REQUIREMENTS

The heating systems required for this project shall be as follows:-

1) A new LTHW system to serve the building serving:
   a) air handling coils,
   b) domestic water primary supply.
2) The systems shall comprise all central generating plant, including:
   a) 2 No Air to Water Air source Heat Pumps.
   b) Plate heat exchanger(s) providing hydraulic separation of primary and secondary heating circuits.
   c) Thermal stores / buffer vessels.
   d) Pipework distribution and control systems
3) Generally, all systems as detailed on the design schematic drawing and following clauses.

M2-2 SYSTEM DESIGN OPERATING VALUES

M2-2-1 SYSTEM TEMPERATURES

Refer to the Design Standards (Section 06).

M2-2-2 SYSTEM PRESSURE

SYSTEM DESIGN PRESSURE	
Entire installation pressure rating	PN16
Normal system operating pressure	0.5 to 4 Bar.g
System test pressure	Refer to section 2A-5

M2-2-3 REDUNDANCY REQUIREMENTS

To ensure acceptable operation of the building systems are maintained in the event of boiler failure, the main plant shall be designed and installed to provide:

1) 2 No each rated at 66% capacity
2) All single pumps shall be provided as 100% run and 100% standby configuration.
3) All twin head pumps shall be provided as 100% run and 100% standby capacity.
4) All additional requirements refer to the design schematic drawings.

M2-3 DEFINITIONS

Refer to Section 1B and 2A to 2D inclusive for general definitions plus:

DEFINITIONS			
ABV or BPV	Automatic Bypass Valve	LST	Low surface temperature
CHP	Combined Heat and Power Unit	LT	Low Temperature
DPR	Stabilising differential pressure regulators	PHX or PHE	Plate heat exchanger
HT	High temperature	TRV	Thermostatic Radiator Valve
LSV	Lock shield valve	VFC	Volt free contact

M2-4 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred pipework material and standards or utilise one of the alternative materials and standards of construction listed in section 2A clause 2A-1-4 detailed earlier in this specification.

The agreed alternative materials from the preferred standard material and standards for this project are:-

No deviation from Section 2 preferred material requirements is permitted.

Note that under no circumstances shall galvanised steel pipework be installed in closed loop heating systems. On inspection of installation, should it be found that this type of pipework has been installed, it shall be removed and replaced at the Contractor's expense.

M2-5 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled in section 2 standards and below:

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STANDARDS	
BSRIA Commissioning Codes	BS EN 10255 Non-alloy steel tubes suitable for welding and threading
BS 853 Specifications for vessels for use in heating systems	BS EN 13501 Fire classification of construction products and building elements
BS 1566 Copper indirect cylinders for domestic purposes	BS EN 10028 Flat products made of steels for pressure purposes
BSRIA Standards	BS EN 16297 Pumps. Rotodynamic pumps. Glandless circulators
BS 6144 Specification for expansion vessels using an internal diaphragm	BS EN 16752 Centrifugal pumps. Test procedure for seal packings
Pressure Equipment Regulations	BS EN ISO 14414 Pump system energy assessment

HEAT PUMP STANDARDS	
BESA RAC 80 – for the application of DX Air conditioning and Heat Pump Equipment	BS EN 16147 Heat Pumps with electrically driven compressors. Testing and requirements for marking of domestic hot water units.
BESA TR30 – Heat Pumps	MCS 020 Planning standard for permitted development installation of wind turbines and air source heat pumps on domestic premises.
BS EN 14511 Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors. Terms and conditions	MIS 3005 – Microgeneration Installation Standard
BS EN 14825 Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors, for space heating and cooling. Testing and rating at part load conditions and calculation of seasonal performance.	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M2-6 SCOPE OF WORKS

The following brief descriptions identify those systems required for installation on this project. Comprehensive system requirements shall be detailed in the subsequent clauses of this specification together with schematic and design drawings.

The LTHW heating system installation shall include for all necessary tools, labour, materials and equipment to design, supply, install, commission and put into operation the heating services, including the following:-

1) 2 No. Air source heat pumps. Coils shall be treated for saline / coastal environment with epoxidic treatment.
2) Plate heat exchanger.
3) Thermal Stores
4) Pressurisation unit with expansion vessel(s)
5) Chemical Dosing pot
6) De-aerator and dirt separator.
7) Primary and secondary circuit pumps to provide a complete installation. All pumps shall be fully inverter driven and shall be separate run and standby pumps
8) All necessary two pipe heating distribution pipework, valves, brackets and fittings to all circuits.
9) All control valves, actuators (sized, selected and provided by the Control Specialist)
10) All sensor pockets and control interfaces required by the BMS to full integrate with the heating system.
11) All necessary trace heating systems to external sections of pipework
12) All pressure by-pass and pressure regulating valves to maximise the energy saving potential of the variable speed pumps.
13) All necessary flushing, filling and venting of all services
14) All necessary commissioning stations for system balancing
15) All testing, witnessing hydraulic pressure tests, balancing, venting and commissioning.
16) All thermal insulation in compliance with earlier section of this specification.
17) Electric panel heaters.

The following are the requirements that are common to all of the systems described above:

1) Liaison with other trades on site.
2) Copies of Operating and Maintenance instruction manuals including a 'brief description' of services and fault finding information list of spares, emergency telephone Nos. etc.

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3) Full user instruction, both written and in the form of demonstrations.
4) All primary and secondary support systems to install the services.
5) Complete electrical installation works associated with this Section of the Specification including all cabling, local isolation and protective devices.
6) Development of the Consultants drawings and detailing from the base tender information to full construction standards as detailed previously. This shall include responsibility for the following areas:-
   a) Support systems/brackets for all services.
   b) Expansion and contraction within the system networks.
   c) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.
   d) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents.
   e) Development of the controls specification for the hardware, software, power, controls wiring and all associated equipment.

M2-7 COMMERCIAL AIR-SOURCE HEAT PUMP (ASHP)

Include for the supply, delivery, installation and commissioning of the air to water heat pump units. The heat pump units shall:

1) Be installed, tested and commissioned fully in accordance with particular heat pump manufacturer's best practice recommendations.
2) Energy Technology Criteria List certified.
3) Be capable of heating down to -20°C.
4) Be "monobloc" type only.
5) Incorporate a defrost cycle allowing continued operation.
6) Provided with integral hydronic side frost protection.
7) Meet acoustic requirements detailed elsewhere in this specification.
8) Be fully compliant with Microgeneration Certification Scheme (MCS) and provided with an MCS certificate on completion.
9) Demonstrate SCOP for the design source range (ambient air) and sink temperatures to be signed off by the consulting engineer.
10) Be provided with anti-vibration mounts.
11) Be installed with flow switch to prevent heat pump operation until flow is established.
12) Be provided with inline strainer into each heat pump.
13) Be provided with a suitable condensate for its environment complete with suitable trap.
14) Be installed by a trained individual suitable for the refrigerant type and charge volume.
15) Be CE Marked.
16) Be installed with separate local electrical isolators provided for each heat pump and condensate drain heaters.
17) Be supplied and installed with the following manufacturers accessories on each ASHP:
   a) Wind guards.
   b) Condensate drain trays with electric frost protection element (with anti-vibration pads above and below trays).
   c) Mounted on raised stand to maximise airflow and avoid snow blocking coils.
   d) Complete with epoxidic treatment suitable for coastal conditions.

Each unit shall be fully factory tested, prior to delivery, and complete with manufacturer's warranty for a minimum of 12 months from practical completion.

The heat pump installation and commissioning shall follow the BESA TR30 / Heat Pumps – Guide to Good Practice.

Each heat pump cabinet shall be manufactured from heavy gauge, powder coated galvanised steel. The casings shall include all relevant knock-out panels for interconnecting electrical and controls wiring.

All heat pump units shall include a sealed refrigerant circuit including scroll compressor(s), thermostatic expansion valve(s) assembly, reversible acting valve(s), water to refrigerant stainless-steel heat exchanger(s), factory fitted high- and low-pressure safety devices and in-line filter(s).

The multiple heat pump unit(s) arrangement, shall be controlled to provide heating via the heat pump controller.

All controls and safety devices shall be factory fitted and pre-wired within each unit, and fully certified to comply with all current British Standards and 18th Edition of the IEE Regulations.

M2-8 LTHW PRESSURISATION SET

Supply, delivery, installation and commissioning of the heating system water pressurisation unit and expansion vessel(s) The pressurisation unit(s) shall be complete with the following features:-

1) Performance as detailed in the appendix to this section.
2) Back flow pressure prevention to suit water in system (Category 4 as minimum)
3) Break tank, ball valve and float.
4) Drain valves and means of isolation for all components.
5) Pressurisation Pump.

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6) All interconnecting wiring and a control panel suitable for connection to a 1 phase, 240 volts, 50Hz electrical supply.
7) Local electrical isolator.
8) All interconnecting pipework valves and fittings.
9) Test button.
10) Pump start frequency/leakage detector.
11) High and low pressure alarm.
12) LCD Display on the front of the control pan
13) Controlled to automatically share duty between run and standby pumps for even wear.
14) All components shall be suitable to allow for system fill in 4 Hours

The pressurisation unit is to be compatible with the Controls system, as detailed later in the Specification. Should the pressure switches be activated this shall deactivate the plant via the controls (hard wire interlocked) and shall provide the alarm conditions detailed within the appendix.

The pressurisation unit control panel shall incorporate a programmable microprocessor which shall, on demand, indicate the following settings on the fascia: -

1) System working pressure.
2) Cold fill pressure setting.
3) High pressure alarm setting.
4) Low pressure alarm setting.
5) Minimum pump running time (delay between pump starts).
6) High system pressure.
7) Low system pressure.
8) System 'leakage' (frequent pump starts).
9) Transducer failed.
10) Run and tripped lamps for each pump.
11) Panel live lamp.

Volt free contacts shall be fitted within the pressurisation unit control panel to allow remote monitoring by the BMS as detailed in the equipment schedule.

The expansion vessel(s) shall:

1) Have sufficient volume to take the expansion of the entire system from ambient to highest working possible temperature.
2) Final system volumes to be verified.
3) Include EPDM type diaphragm (suitable for 100 degree C).
4) Be complete with wall or floor support frame provided by the expansion vessel manufacturer.
5) Be provided by the pressurisation manufacturer.
6) System shall be installed with anti-gravity loop on discharge.

M2-9 LTHW CHEMICAL DOSING POT

To enable water treatment to be added to each heating system, a dosing pot shall be provided and connected across the system flow and return to enable maintenance doses of chemicals to be added.

The dosing pot shall be:

1) Of at least 13.5 litre capacity.
2) Manufactured from same material as the pipework, fully welded or brazed as appropriate.
3) Complete with pre-mounted gate valves and non-return valve in the filling line.

Note – the non-return valve is a mandatory requirement to minimise health and safety risk of incorrect use of the dosing pot.

Chemical dosing shall be:

1) Initial test/dosing shall be completed prior to first application of heat.
2) Second test dosing shall take place immediately prior to end of defects period.
3) All water testing necessary to determine what level and type of treatment is to be provided shall be included.

Water treatment dosing pot shall be by:

- Arrow Valves Limited.
- N. Minikin & Sons Limited.
- Water Treatment Products.
- Stourflex (J&P Supplies Limited).
- Messrs. Houseman Ltd.
- Flex EJ Limited.

M2-10 PLATE HEAT EXCHANGERS

The plate heat exchangers shall interface between the primary and secondary heating circuits to provide full hydraulic separation.

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Each packaged hot water plate heat exchanger shall be fully compliant with the technical requirements detailed in the schedule at the end of this section and be complete with the following:

1) The overall casing shall be manufactured from epoxy coated steel and shall be suitable to accept the insulation proprietary removable insulation jackets that shall insulate all hot surfaces.
2) Complete with removable insulated jacket to insulate all surfaces.
3) Heat exchange plates shall be stainless steel 316L with gaskets suitable for fluids handled.
4) Temperature control of the secondary circuit is achieved by a three port mixing control valve to the primary side of the PHE and variable speed LTHW pump(s).
5) The unit shall have minimum 20% spare capacity that can be added by the installation of additional plates to the steel frame with associated increase in pressure loss limited to 20% increase.
6) Be designed for single pass opposing direction.

PHE shall be sized and manufactured by the same manufacturer as the air to water air source heat pumps.

M2-11 SEPARATE DE-AERATOR AND DIRT SEPARATOR

As detailed on the tender drawings a separate de-aerator and dirt separator unit shall be provided as shown on the tender drawings.

De-aerator

The unit shall be:

1) Installed at the point of highest temperature/lowest pressure to aid air removal.
2) Installed with isolation valve and binder test points either side of unit.
3) Made from 5mm thick high grade heavy carbon steel (or better) with flanged connections.
4) Suitably pressure rated.
5) Installed to the recommendation of the manufacturer.
6) Complete with 1 No. high quality automatic air vent (c/w NRV connection for ease of replacement) with threaded connection for vent pipe
7) Complete with 1 No. 25mm releasing valve for purging through installation stage.
8) Complete with 1 No. 32mm drain valve.
9) Refer to manufacturer's recommendations for Maximum Static Head pressure

Dirt Separator

The unit shall be:

1) Installed to ensure the heating equipment is protected from suspended products to ensure all equipment manufacturer's warranties are maintained.
2) Made of Steel or Brass.
3) Suitably pressure rated.
4) Installed in pipework where the velocity of 3m/s maximum is not exceeded.
5) Installed on return pipework prior to boilers.
6) Provide filtration down to 20 microns.
7) Provided with Isolation drain valve and suitable connections for draining/cleaning.

Components shall be installed fully in accordance with the manufacturer's requirements in terms of position in the pipework installation to ensure maximum efficiency of removing air and 'dirt' from the system.

Manufactured by:

- Hamworthy Ltd
- Spirotech
- BSS

M2-12 LOW TEMPERATURE HOT WATER HEATING PUMPS

In the positions indicated on the schematic drawing(s) system pumps shall be supplied, installation and full commissioned. Pumps shall comply with the technical details as described in the appended schedules.

All pumps shall be variable speed controlled by inverters. Where pumps are required to operate at a constant speed these also shall be provided as variable speed to allow for accurate setting of flow rates during commissioning.

Inverters shall be separate from the pumps, either built into the control panels or local to the pumps on free standing supports as detailed in the controls section of this specification and not be incorporated into the pump assembly.

Unless detailed otherwise in the appendix pressure transducers shall be provided as follows:

a) Flow rate below 0.5l/s, integral pressure transducer and integral controller to maintain constant pressure or proportional pressure, selectable at commissioning
b) Flow rate above 0.5l/s, external pressure transducer(s) installed halfway along each main index circuit, set to maintain constant pressure and to comply with Building Regulations carbon compliance model.
c) Where an electronic commissioning / programming device is available from the manufacturer one of these shall be supplied and handed over to the Engineer / Client at handover stage.

All circulating pump sets to serve the LTHW water circuits shall be as detailed below:

1) The equipment shall be CE certified.

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2) Fully compliant with Energy related Products.
3) All Pump Motors to be IE 3 rated.
4) Compliant with EU 547/2012, EU 640/2009 & EU 641/2009.
5) Fully suitable for the pumped water / fluid.
6) Equipment shall comply with latest European Legislation relating to mains borne interference/harmonize and the isolation of the same.
7) Line size isolation valve on suction and discharge.
8) Line size strainers on suction and non-return valves on discharge where separate run/standby pumps installed.
9) Flexible connections on suction and discharge.
10) All components to be line size with reducers used immediately adjacent to pumps.
11) Pump suction and discharge binder test points.
12) Pump suction and delivery manifolds to be fitted with 100mm dial pressure gauges fitted with a 9mm syphon and valve.
13) Each pump motor shall be sized to have a shaft power of not less than the maximum pump absorbed power at any point on its characteristic curve plus a margin of 10%.
14) Each pump shall be suitable for operating within a temperature range of minus 10°C – 110°C for LTHW and with a positive pressure available from the pressurisation unit as detailed on the pressurisation schedule and the schematic drawing(s).
15) Pairs of single head run /standby pumps shall be provided with line size non-return valve on discharge.
16) A differential Pressure sensor shall be fitted across each pump set.
17) The construction characteristics of each pump must comply with the following:-
    a) Cast iron casing.
    b) Impeller - cast bronze, fully enclosed dynamically balanced (pumps shall be selected for mid impeller size)
    c) Shaft - stainless steel.
    d) Bearings – sealed for life type.
    e) Shaft seal - Mechanical type with hardened ceramic seal and carbon seal ring.
    f) Pump connections - flanged.
    g) Each size of twin head pump set shall be complete with a single set of blanking plates for isolation and maintenance of the motor heads. Plates shall be wall mounted adjacent to the pumps.
    h) A common base shall be provided for each pump and motor assembly
    i) Each pump shall be provided with an inertia base. The inertia bases are to be provided with spring anti-vibration mountings with a vibration efficiency of 98% minimum to limit vibration transmission to the building.

Each inertia base shall be manufactured by:

- TEK Ltd.
- Ormandy Ltd
- AVC Ltd.

Pumps shall be controlled via the BMS to respond to system requirements. All invertor control settings shall be recorded and included in the O & M Manuals.

All variable speed pumps shall be commissioned by the pump and inverter manufacturer.

M2-13 THERMAL STORE(S)

A thermal store shall be installed within the plantroom as detailed on the design drawings. The store shall be a low temperature hot water thermal stratification store as detailed on the appended schedule and shall be:

1) Vertical type construction to encourage the greatest amount of stratification possible.
2) Be manufactured from fully welded heavy grade Carbon Steel construction.
3) Be manufactured in accordance with current British Standards
4) Be fully corrosion treated internally and externally
5) Pre-insulated including the inspection hatch, necks etc. with minimum of 125mm thick high density mineral wool having a thermal conductivity of 0.04(W/m·K) and be complete with stucco aluminium finish.
6) Complete with baffles, sparge pipes, diffusers and internal pipework to optimise stratification and ensure entire volume of vessel is used. Refer to schedule.
7) Be provided with all necessary thermal sensor pockets at regular height intervals as required to provide accurate temperature monitoring and control (a minimum of 5 sensors points shall be provided – or more onerous for method of control required.)
8) Fabrication drawings shall be issued to the Engineer and Insurer for comment prior to commencing manufacture. Information shall include Pressure Certification
9) Testing shall be completed at the manufacturer's works including:
    a) Full hydraulic pressure test with specific test certificate (type testing shall not be accepted).
    b) Minimum 50% X-ray of each longitudinal and circumferential butt joint.
    c) Insurer's requirements for testing.
10) Vessel Painted externally with two coats of red oxide primer.
11) Complete with welded fixing lugs for horizontal and vertical transportation / positioning.

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12) Supplied, installed, tested and commissioned in accordance with the manufacturers recommendations.

The primary side thermal store shall be sized by the same manufacturer of the air to water air source heat pumps to prevent lockouts due to the low water content on the primary circuit.

M2-14 OVER DOOR HEATERS

Electric over door heaters shall be installed as detailed in the appended schedules and indicated on the tender drawings. The heaters shall:

1) Be three speed units selected to provide specified duty at mid speed.
2) Be selected to comply with room noise level when operating at mid speed. For tender assume no greater than NR40 at 3 metres.
3) Be selected to match the door width opening.
4) Be provided with manufacturers fan speed controller
5) Be complete with supply air temperature sensor and room temperature sensor.
6) Be complete with return air temperature sensor and room temperature sensor.
7) Have remote stop/start facility.
8) Be suitable for remote enable signal from BMS.
9) Suitable for top hung support.
10) Suitable for Concealed/void mounting c/w intake / discharge grilles and all interconnecting ductwork.
11) Be complete with all power and control wiring.

M2-15 AUTOMATIC CONTROLS

Refer to Control Section for details.

Where control valves are installed local pipe sizes may be of a different size, due allowance shall therefore be made for any necessary reducers.

M2-16 PIPEWORK, VALVES AND FITTINGS

All valves and fittings shall be as detailed in General Installation Standards.

M2-17 THERMAL INSULATION

The whole of the heating pipework shall be thermally insulated. All insulation shall be as detailed in General Installation Standards.

M2-18 TESTING AND COMMISSIONING

Testing and commissioning shall be carried out fully in accordance with General Installation Standards of this Specification.

M2-19 EXPANSION AND CONTRACTION

The selection and installation of all measures to allow for expansion and contraction shall be included for this project. This shall be in the form of loops, bellows, anchors, guides, offsets, rollers/chairs and cold draw.

Wherever feasible, natural flexibility solutions shall be employed. All provisions for expansion and contraction shall be indicated on the fabrication drawings submitted with the supporting calculations to the Engineer for comment prior to installation taking place.

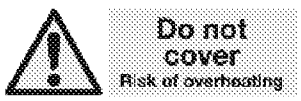
In the event that natural flexibility cannot be used due to building fabric restraints, bellows shall be installed which shall:

1) Be multi-layered stainless steel (316L) quality units
2) As manufactured by:
   a) Pipe Solutions (01423 878888)
   b) Bellows Technology Ltd (01663 745873)
   c) FLEXEJ Ltd (01384 881188)

M2-20 ELECTRIC LOW SURFACE TEMPERATURE PANEL HEATERS

Electric LST panel heaters shall be installed and commissioned in the positions indicated on the drawings and in accordance with the appended schedule. The panels shall be as detailed below:

1) The panels shall be robust design fully suitable for the locations that they are being installed.
2) Wall mounted design complete with manufacturer supplied wall brackets. Fixings to incorporate wall bracket allowing the heater to hinge forward for decorating or cleaning with hinge incorporating locking facility for safety.
3) Complete with built in overload protection.
4) Complete with automatic resetting overheat protection to prevent the surface and internals from overheating.
5) Provided with warning symbol advising that the heaters are not to be covered as below.



6) Class 2 double insulated and splash proof IP24.
7) Integral silent electronic thermostat for local temperature control.
8) Integral thermostatic control for set point adjustment.

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9) User temperature adjustment with tamperproof upper and lower temperature limits.

10) Installed and tested fully in accordance with the manufacturers recommendations.

M2-21 CHEMICAL DOSING

The system shall be chemically dosed with corrosion inhibitor and the sealing treatment as described within Section 2.

A total of two dosing sessions shall be provided: -

1) Prior to practical completion.

2) Prior to the end of the defects period.

All water testing necessary to determine what level of treatment is to be provided shall be included within the tender.

The external heat pump circuit shall be dosed with 20% inhibited mono-ethylene glycol to minimise risk of freezing.

Water quality shall be in accordance with the recommendations / requirements of the heat pump manufacturer when taking into account the design water temperatures.

The internal heat pump circuit shall be filled with 100% water with inhibitor and corrosion treatment.

M2-22 TRACE HEATING

All external pipework or any other pipework subject to freezing temperatures shall be electrically trace heated with self-regulating trace heating system.

Trace heating tape shall be activated wherever outside ambient drops below 3°C or whenever crank case heaters are activated.

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M2-23 APPENDICES

NB – Duties given for the purposed of First Stage D & B Tender only. Final duties and properties to be developed by the Building Services Contractor during second stage process for full design responsibility.

M2-23-1 AIR SOURCE HEAT PUMP(S)

AIR SOURCE HEAT PUMP(S)	
Location	Externally mounted
Refrigerant	HFC R407C / R32 / HFC R410a / R513A
Quantity	2 no.
Duty	Allow each sized at 71.2 kW @ 7deg C ambient / 56.4 kW @ -4 deg C
'Winter Ambient' Condition for selection	-8°C, 100%RH
Ambient Summer Condition for normal operation	35°C, 50%RH
Heating water	65°C flow temperature / 55°C return temperature
Capacity control	Fully modulating by inverter.
Maximum water side pressure drop	30KPa
Design water flow rate	TBC by the designer
Glycol Levels	TBC by the designer
Normal Working Pressure	Refer to clause M5-2 for 'System Design Operating Values'
System test pressure	Refer to clause M5-2 for 'System Design Operating Values'
Power Supply Mains	400 Volt / 3 phase / 50 Hz
Power Supply Heaters and frost protection.	230 Volt / 1 phase /50 Hz – 16A maximum.
Condenser fins	Copper tubes with aluminium fins.
Additional features required	• Electronic expansion valves. • Inverter driven compressors. • Inverter driven airside fans. • Trace heating tape & frost protection. • Saline / coastal protection - coils with epoxidic treatment suitable for coastal conditions)
Maximum noise level	62dB A-weighted at 1 metres unless stated elsewhere.
BMS / Controls interfaces	BMS MODBus interface card or hard wiring to provide as a minimum the following: • Remote stop / start for time clock control. • Remote stop for fault (also linked to flow switch). • Remote chilled water set point adjustment (fully proportional between chiller's minimum and maximum set point capability). • Non-critical fault indication. • Critical fault indication / failure. • 0-10v input from BMS to set heat pump flow temperature.
Manufacturer: • Stiebel Heating Technology – Alpha Model S-ACA 70 or similar.	

M2-23-2 THERMAL STORES

HEATING CIRCUIT THERMAL STORE VESSEL	
Location	Mounted internally located in plant room.
Vessel minimum capacity.	TBC by the designer
Approximate Size:	Capacity to meet design requirements.
General Construction and leg assembly	Black mild steel plate with convex base
Working Pressure	Refer to clause M5-2 for 'System Design Operating Values'
Test Pressure	Refer to clause M5-2 for 'System Design Operating Values'

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HEATING CIRCUIT THERMAL STORE VESSEL	
Connections	Refer to schematic drawing.
Components required	25mm Anti Vacuum Valve at top. 25mm Safety Valve at top. 100mm diameter temperature gauge. Pockets for temperature sensors (BMS) as detailed in schematic. 25mm drain at base of vessel (lowest point). Minimum of three legs / feet for bolting to level surface – one leg / foot to be adjustable to accommodate floor fluctuations.
Inspection cover	Min. 500mm Diameter.
Insulation	Applied at manufacturing stage, 75mm phenolic foam (0.035 W/mk) or equal performance, finished with vapour seal.
Cladding	Applied at manufacturing stage to be plastisol protective cover as detailed in section two of this specification.
Promotion of stratification	TBC by the designer Low velocity discharge diffusers for in flow and return connections.
Manufacturer: • Cheminox Ltd • Lochinvar Ltd • Hoval Ltd • Spirotech Heating Technology	

M2-23-3 LTHW PUMPS

LTHW PUMPS							
Ref	Description	Quantity	Duty (l/s)	Pressure (kPa)	Speed Control	Type	Power Supply
	Primary Heating Pumps	Single head	TBC	TBC	Inverter	Inline	3 phase
	Secondary Heating Pump Sets	Twin head	TBC	TBC	Inverter	Inline	3 phase
Electrical efficiency					To achieve: EEI = < 0.20 MEI = >0.40		
BMS Interfaces					Common fault from inverter to BMS 0-10v from BMS to determine pump speed. Enable signal from BMS to start pump.		
Design temperature and pressure					Refer to clause M2-2 for 'System Design Operating Values'		
Manufactured by:- • Armstrong Pumps Ltd • Grundfos Ltd							

M2-23-4 PLATE HEAT EXCHANGER

LTHW PLATE HEAT EXCHANGER	
Description	Requirement
Quantity	Refer to schematic
Location	Plant room
Primary Fluid	Flow 65°C Return 55°C Flow TBC by the designer

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LTHW PLATE HEAT EXCHANGER	
Description	Requirement
	Max Pressure Drop 35kPa
Secondary Fluid	Flow 63°C Return 55 °C Flow TBC by the designer Max Pressure Drop 35kPa
Design temperature and pressure	Refer to clause M2-2 for 'System Design Operating Values'
Capacity	TBC by the designer
Expansion vessel	TBC by the designer
Manufactured by: • Bowman Heating Technology	

M2-23-5 OVERDOOR HEATERS

OVERDOOR HEATERS							
Selection based on temperatures & pressures in clause M2-2 'System Design Operating Values'							
Ref	Location	Output Required (kW)	LTHW / Electric Heater	Air Discharge Height (m)	Power Supply	NR rating	Model
1	Main Lobby	TBC by the designer – Min 18 kW	Electric	TBC by the designer	415/3ph/50Hz	NR45	
Manufacturers' accessories for all models				Fan speed controller Summer/winter operational control			
BMS Interface for all models				Enable Common fault High heat current trip			
Manufacturers: • Airblade Air Systems • Diffusion Environmental Systems • Envirotec Limited							

M2-23-6 ELECTRIC PANEL HEATERS

ELECTRIC PANEL HEATERS				
Selection based on temperatures in clause M2-2 'System Design Operating Values'				
Ref	Room Design Temp. (°C)	Actual Output (kW)	Model Reference	Integral Controls
All Residential Areas.	See Section 6 – Design Standards	TBC by the designer	TBC by the designer and agreed with engineer / architect	Thermostatic, 7 day time switch and adaptive control
All back of house / staff only areas	See Section 6 – Design Standards	TBC by the designer	Dimplex Girona Panel Heater (Black Glass)	Thermostatic, 7 day time switch and adaptive control

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Section M3

Mechanical Ventilation Systems

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M3-1 GENERAL REQUIREMENTS

The project is ventilated through a mixed approach of both natural and mechanical ventilation means.

The mechanical ventilation systems required for this project shall be as follows:

1) Natural ventilation via openable windows and trickle ventilators to occupied areas of the building including communal spaces and residential bedrooms.
2) Ceiling void mounted heat recovery units providing supply and extract ventilation to landlocked and other occupied areas of the building.
3) Individual bedroom en-suite extract ventilation systems.
4) Laundry dryer exhaust and make up supply ventilation systems.
5) Kitchen supply air handling unit and extract fan system located on the flat roof of the building.
6) Local extract fans shall be provided to each WC, shower, dining and kitchenette areas.
7) Any other ventilation system requirement not covered in the above but detailed within the tender documents.
8) Appropriate means of fire stopping in line with this specification and the Fire Engineers requirements.

M3-2 REDUNDANCY REQUIREMENTS

No redundant capacity is provided for the mechanical ventilation systems.

M3-3 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS			
AHU	Air Handling Unit	SFP	Specific Fan Power
BCO	Building Control Officer	VAV	Variable Air Volume
CV	Constant Volume	VCD	Volume Control Damper
DX	Direct Expansion (refrigerant system)	VFC	Volt Free Contacts
PHE	Plate Heat Exchanger	VRF	Variable Refrigerant Flow
RAC	Run Around Coil Heat Exchanger	VRV	Variable Refrigerant Volume

M3-4 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

Sections 2 Standards provides all necessary details on Ductwork, Mechanical Commissioning and Thermal Insulation requirements that apply to this section. The following text advises if the Contractor shall deviate from the preferred requirements detailed in standard sections. Agreed amendments from the preferred standards are:

All ductwork shall be galvanised steel fully in accordance with DW144.

No deviation from the section 2 preferred requirements.

If system is installed strictly in accordance with DW144/DW172 then pressure testing of Class A general supply and extract systems is not required for this project. Note if deviation from the standards is observed on site then pressure testing will be required in accordance with section 2 of this specification at contractors own expense.

M3-5 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BESA Guides including DW Series.	BSRIA Commissioning codes
BS 7671 Requirements for electrical installations. IET Wiring Regulations	BSRIA Standards
BS 9999 Code of practice for fire safety in the design, management and use of buildings	Building Regulations
BS EN 1751 Ventilation for buildings	CIBSE Commissioning Codes in particular R – Refrigeration and M – Management
BS EN 1886 Ventilation for buildings. Air handling units. Mechanical performance	Eco-design Directives, in particular Commission Regulations in particular EU No 1253/2014 and 1254/2014
BS EN 13501 Fire classification of construction products and building elements	Non-Domestic Building Services Compliance Guide
BS EN 60038 CENELEC standard voltages	

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Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M3-6 SCOPE OF WORKS

The following brief description identifies those systems required for installation on this project. Comprehensive system requirements shall be detailed in the subsequent clauses of this specification together with schematic and design drawings.

The mechanical ventilation installations shall include for all necessary tools, labour, materials and equipment to supply, install, commission and put into operation the ventilation system, including the following:

1) All air handling plant, heat recovery units, supply and extract ventilation systems.
2) Ensuite / bedroom extract ventilation and fire rated galvanised extract ductwork / support systems through the ceiling/roof void.
3) All specialist laundry exhaust and supply make up ventilation systems and fans located on the flat roof of the building.
4) All laundry general ventilation supply and extract ventilation and heat recovery unit located on the flat roof of the building.
5) All kitchen canopy supply and extract ventilation systems with supply air handling plant and extract fan located on the flat roof of the building. All associated supply and extract ductwork and supports systems shall be fire rated through the ceiling/roof void.
6) Supply ventilation to kitchen office and dry store.
7) Include for protection to all external mechanical ventilation plant and external support systems against coastal / saline environment.
8) Design and advice for free area openings for all naturally ventilated areas.
9) All plant primary and secondary support systems. All roof plant shall be cited on spreader type supports systems as agreed with the structural engineer.
10) All ductwork, support brackets and secondary steelwork supports into and from AHUs to grilles and diffusers.
11) Thermal insulation as detailed in the standards section.
12) All associated ductwork and fire/smoke dampers and fire rated ductwork systems in accordance with the Fire Advisor and Building Control Officer.
13) All main, secondary and crosstalk attenuators and acoustic treatment.
14) All grilles and diffusers.
15) All primary and secondary support systems to install the air handling units and all associated services.
16) Development of the Consultants drawings and detailing from the base tender information to full construction standards as detailed previously. Liaise and co-ordinate mechanical works with all other trades on site.
17) Provide development of the drawings and detailing from the base tender information to fully designed and constructed standards as detailed previously. This shall include full design responsibility (but not limited to) as follows: -
    a) Support systems/brackets for all services.
    b) Expansion and contraction within the system networks.
    c) Detailed design and full co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line three dimensional services fabrication drawings using proprietary BIM modelling software e.g. Revit etc.
    d) Development and adoption of the Consultants' concept for equipment and the systems specified to achieve the criteria described within the tender documents.
    e) Design development of the Controls Performance Specification for the hardware, software, power, controls wiring and all associated equipment.
    f) Preparation of co-ordinated ceiling and elevation drawings (1:50) showing all mechanical and electrical services outlets including the Specialist(s) Contractor's equipment.

M3-7 AIR HANDLING UNITS

M3-7-1 AIR HANDLING UNITS' CONFIGURATION

The order of air handling unit components are detailed on the tender schematics. Air handling units shall be manufactured by one of the manufacturers listed in the schedule at the end of this section.

All the air handling units shall be by the same manufacturer and be suitable for the installation in the locations advised i.e. external units shall be fully weatherproof with sloping roof, guttering and downpipes. Internally located units do not have this requirement.

The configuration of the air handling units components shall only be amended if agreed with the Engineer and after any changes in component order are energy beneficial, offer easier maintenance or similar. Under no circumstances shall components be omitted or re-arranged purely to value engineer and reduce the capital cost of the air handling units.

M3-7-2 ENERGY RELATED PRODUCTS EFFICIENCY AND PART L COMPLIANCE

The units and components shall also be selected to present minimum resistance to air flow in order to ensure that the fans can be selected to achieve the maximum fan power per litre of air specified, required to comply with Approved Document Part L energy efficiency or to comply with EU Regulations with whichever is the lower energy consumption value being adopted for the project.

The manufacturer shall ensure that components are selected such that when providing the external static pressure specified the unit complies with Part L limits and full compliance with EU Regulation 1253/2014 for standard requirements.

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Simple Required Specific Fan Power for Air Handling Unit Compliance of EU Regulation 1253/2014							
Airflow	66% efficient Run Around Coil		75% efficient Plate Heat Exchanger		66% efficient Thermal Wheel		Note
	F7 filter in supply / M5 filter in extract	F7 filter in supply / G4 filter in extract	F7 filter in supply / M5 filter in extract	F7 filter in supply / G4 filter in extract	F7 filter in supply / M5 filter in extract	F7 filter in supply / G4 filter in extract	
l/s	W/l/s	W/l/s	W/l/s	W/l/s	W/l/s	W/l/s	
<2,000	1.38	1.23	0.94	0.79	1.24	1.09	Based on 500l/s – actual values vary with airflow
2,000 +	1.1	0.95	0.86	0.71	1.16	1.01	

Full calculations proving full compliance with EU Regulation 1253/2014 for current standard requirements shall be provided BEFORE the air handling units are ordered to avoid both contractual and programming issues of the AHUs not meeting this requirement. It is the responsibility of the tenderer to ensure all quotations are fully compliant.

Manufacturer shall produce calculations to prove that ALL of the above has been fully complied with, specifically:

1) Calculations shall be completed as laid down in the Non-Domestic Building Services Compliance Guide including the following additional requirements:
2) Where inverter / control gear efficiency is not known assume 90% efficient.
3) Base calculations upon whichever of the supply or extract air flows are the greater.
4) Base calculations upon the design external static pressure with all filters at their clean condition in pressure drop.
5) The Mechanical Contractor shall provide evidence to demonstrate that specific fan power at 25% of design flow rate is no greater than specific fan power at 100% of design flow rate.
6) Each fan or AHU shall be assessed individually.
7) Final and complete calculations proving full compliance with EU Regulation 1253/2014 for current standard requirements shall be provided.

M3-7-3 REVIEW OF CONNECTIONS

Review the number of connections offered by the preferred supplier as the number of connections varies between different manufacturers.

Where the number of final connections to the coil section or dampers varies from that indicated on the tender drawings, due allowance shall be made for the additional pipework, fittings, control valves, actuators, wiring etc. All costs associated with any changes in the number of AHU connections and handing of the connections shall be included in the tender return.

All coils over 1000mm tall or wide shall be connected via reverse return headers for heating and cooling systems.

M3-7-4 UNITS SIZE / POSITIONING

The units shall be manufactured to the approximate proportions detailed on the drawings and shall be supplied in the component sections.

The sizes of equipment are required to fit into the plant location whose size and height is fixed. The plant space allocation is of fixed height therefore plant dimensions shall reflect this restriction.

The AHU shall be delivered to site in sectional form for construction on site.

All access to the unit shall be from one side of the AHUs as indicated on the tender drawings.

The overall appearance of the unit, including access panels, shall be of a flush finish on the top and the sides. Varying heights and widths of components shall not be allowed.

All roof mounted air handling plant shall be limited in physical height to ensure neither the plant and ductwork systems exceed the ridge height of the pitched roof..

M3-7-5 DELIVERY AND AHU PROTECTION DURING INSTALLATION WORKS

If the air handling units are all internal grade and not suitable for storage externally even if covered in water and weatherproof protection, then the air handling units shall:

1) **Not** be delivered to site unless AHUs can be immediately craned into final position.
2) **Not** delivered to site until the plant room is complete except for a small agreed section of final roof purposely not installed to provide craning access for the AHUs to be craned into the plant room.
3) **Not** delivered to the plant room until the plant room has been demonstrated to the satisfaction of the M&E clerk of works that the plant room is watertight.

The units specified shall be of a high quality and for this reason, the unit shall be delivered to site in proprietary protective casing which shall:

1) Consist of plastic and impact resistant material to prevent scratches etc. in a normal construction environment.
2) Casing shall be redressed around the unit and connections after site assembly has been completed.
3) Ensure that the casing is kept in good condition, with the covering being replaced or providing supplemental protection as necessary to ensure the unit remains in "as new" condition. Any damage to the units shall be made good at Contractor's expense.

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Irrespective of whether the units are internal or external type, the units shall not be left open or used for storage of tools or materials during the works, should this occur the unit shall be fully refurbished by the AHU manufacturer and cleaned by a Specialist Contractor at no cost to the client.

M3-7-6 AHU CASING CONSTRUCTION

Unless stated otherwise in the schedules the AHU shall be designed to achieve the following standards.

AHU CASING DESIGN STANDARDS REFER TO BS EN 1886		
AHU construction filtration standard (for clean & dirty sides of filtration in critical ventilation systems) Refer to BS EN 779 and BS EN 1822 Part 1	Casing Air Leakage Classification (L)	Mechanical Strength of Casing Classification (D)
F8, F9, E10, E11, E12, H13 or H14	L1	D1
G1, G2, G3, G4, M5, M6 or F7	L2	D2

AHU CASING THERMAL PERFORMANCE REFER TO BS EN 1886			
AHU Location	Thermal Transmittance	Thermal Bridging	Fire Protection
External	T2	TB2	Option 1
Internal (Plant Room, no cooling)	T2	TB2	Option 1
Internal (Ceiling Void, no cooling)	T2	TB2	Option 1
Internal (Plant Room, with cooling)	T2	TB2	Option 1
Internal (Ceiling Void, with cooling)	T2	TB2	Option 1
Fire Protection Option 2 – May be considered only, if agreed with the Engineer, and fire or smoke dampers (as required) are provided as necessary.			

AHU CASING SOUND ATTENUATION IN DECIBELS (WORST ACCEPTABLE ATTENUATION)			
Frequency (Hz)	External AHU	AHU in Plant Room	All other cases
63	12	10	23
125	12	10	22
250	22	19	34
500	26	29	47
1000	26	31	49
2000	26	28	50
4000	27	32	51
8000	29	33	54
Above shall be inclusive of access doors, fixings, pipework / electrical connections etc.			

All the AHUs casing shall:

1) Be of a double skin construction to achieve thermal transmittance and thermal bridging standards specified.
2) Have a zero Ozone Depletion Potential (ODP) rating.
3) Have an external 'scratch resistant' plastic face laminate finish.
4) Have an internal finish of galvanised mild steel, except cooling coils and humidifiers sections that shall be lined with stainless steel (316L). Where access sections are provided with dagger plates or isolation dampers for cleaning either side of a cooling or heat recovery coil then all surfaces within the area being cleaned shall be stainless steel (316L) to allow wet cleaning.
5) Sections of the AHU likely to contain components producing moisture i.e. cooling coils and humidifiers shall also:
   a) Have bottom panels that slope to a plugged drain socket built into the side of the bottom member.
   b) Arranged so that any moisture shall drain off in the event of an overflow emergency from the normal drip trays.
   c) Be designed so that no pooling of water occurs at any time.
   d) Include drain trays shall slope to drains in all directions at a gradient of at least 1 in 20.
   e) Have removable drain trays for sterilisation cleaning purposes.
   f) Have totally accessible drain trays for ease of cleaning.
   g) Be fully HTM 03-01 compliant in accordance with best practice guidelines.

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6) All sealants and gaskets shall comply with water research association requirements for the non-support of bacterial growth i.e. neoprene shall be used not foam strip type.

7) All internal finishes, frames and joints shall be fully smooth and fully suitable for being wiped clean.

The AHU shall be mounted on a steel channel base frame, which shall:

1) Run the entire length of the AHU to evenly distribute load.

2) Suitable strong to support the AHU without deflecting.

3) Be of sufficient height to accommodate condensate U traps of sufficient depth to seal against 120% of the design fan pressure.

4) Be manufactured from:

   a) Mild steel galvanised after manufacture and then powder coated.

Panels that provide access to components shall:

1) Be provided where access is required for maintenance / replacement of AHU components.

2) Any additional access indicated on the Tender drawings and schedules shall be provided.

3) Be of sufficient size to allow reasonable man access and the passage of tools, absolute minimum clear width is 500mm opening.

4) Be of sufficient size to allow large items of installed plant, such as fans / coils, to be easily removed and replaced.

5) Be arranged to allow sufficient space for pipework support and controls wiring to be completed without obstructing door openings, components access or ability to remove components.

6) Complete with floating hinges arranged to allow the access door to move away from the unit before the unit swings open to prevent damage to the gasket sealing system.

7) Provided with seals designed to last at least 20 years with normal maintenance access.

8) The doors shall clamp without imposing a strain on the hinges.

9) Be provided with at least 4 wedge action sealing handles.

10) Be provided with robust and resilient access furniture, this resilience and robustness shall be shown within the working drawings prior to manufacturer and demonstrated during factory testing and to the M&E Clerk of Works on site.

11) Lift off type access shall not be used to any air handling sections. All sections requiring any access shall be hinged only.

Fixed panels shall be provided in all other locations and shall:

1) Be fixed using bolted or screwed fixings (capped), which are not visible from the outside of the unit.

2) Have internal finish of fixings shall be smooth and arranged to prevent collection of dust, mould and bacteria growth.

3) Ensure any sealants used also prevent collection of dust, mould or bacteria growth.

M3-7-7 DAMPERS

All dampers shall:

1) Be of the opposed blade type for sealing and parallel blade type where modulating mixing is required complete with neoprene long life seals, predicted life expectancy of 20 years. For tender allow for parallel blade dampers but confirm with designer prior to manufacture.

2) Be complete with extended shafts, linkages and actuator mounts suitable to accept control actuator.

3) All actuator drives for dampers shall be mounted external to the air handling units.

4) Have a maximum leakage rate of 20 l/s/m² @ 1000Pa.

5) Shall be manufactured from galvanised steel, except for fresh air intake damper which shall be 316 L stainless steel.

6) An 'open damper position' end switch and 'closed damper position' end switch or torque indicator facility is required to each unit to provide closed loop indication of the actual damper position.

M3-7-8 SUPPLY PRE-FILTERS

All pre-filter sections shall be complete with energy efficient pre-filters indicated on the tender drawings and shall be:

1) G4 filter grade.

2) Be 50mm deep to maximise life expectancy.

3) Water resistant construction to withstand both rain and fog OR by design shall not be exposed to frost conditions due to the AHU configuration as all filters are either after a mixing section (provided for frost protection) or in the extract side of the AHUs.

4) Certified as Energy Class 'A' under Eurovent 4/11 when tested in accordance with EN ISO 16890.

5) Be installed within the filter manufacturer's own frames to ensure the grade of filtration is achieved.

6) Filter bypass leakage rate shall not exceed 1% when tested in accordance with BS EN 1886.

7) Front withdrawal frames fully in accordance with the filter manufacturer recommendations to avoid leakage.

8) Designed for easy removal and replacement of filters.

9) Be provided with a calibrated Magnahelic gauges across each filter with clean and dirty condition clearly labelled (mechanically fixed Traffolyte engraved label).

10) Be provided with pressure differential sensors by BMS.

11) Be replaced with new filters following final commissioning of the system and immediately prior to practical completion.

12) A further spare set of all filters shall be handed over to the Client at project handover.

The filters and frames shall be manufactured by:

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- Camfil Limited (01706 238 000) their '30/30 pleated panel filter'.
- Other manufacture of G4 grade filter certified to achieve Energy Class 'A' as stated above.

M3-7-9 SUPPLY MAIN F7 FILTERS

All main supply bag filter sections shall be complete with energy efficient main bag filters indicated on the tender drawings and shall be:

1) F7 bag filter grade.
2) Certified as Energy Class 'A' under Eurovent 4/11 when tested in accordance with EN ISO 16890.
3) Be installed within the filter manufacturer's own frames to ensure the grade of filtration is achieved.
4) Filter bypass leakage rate shall not exceed 1% when tested in accordance with BS EN 1886.
5) Front withdrawal frames fully in accordance with the filter manufacturer recommendations to avoid leakage.
6) Designed for easy removal and replacement of filters.
7) Shall not be exposed to frost conditions due to the AHU configuration as all filters are either after heat recovery, after a mixing section (provided for frost protection) or in the extract side of the AHUs.
8) Be provided with a calibrated Magnahelic gauges across each filter with clean and dirty condition clearly labelled (mechanically fixed Traffolyte engraved label).
9) Be provided with pressure differential sensors by BMS.
10) Be replaced with new filters following final commissioning of the system and immediately prior to practical completion.
11) A further spare set of all filters shall be handed over to the Client at project handover.

The filters and frames shall be manufactured by:

- Camfil Limited (01706 238 000) their 'Hi-Flo M7 50+' bag filter.
- Other manufacture of F7 grade filter certified to achieve Energy Class 'A' as stated above.

M3-7-10 EXTRACT G4 / M5 PANEL FILTERS

G4 panel filters shall fully match the standards and requirements for the G4 Pre-filters.

M3-7-11 DRAINS

Condensate drains from cooling coils, humidifiers and heat recovery devices shall:

1) Comply with CIBSE TM13 HTM and L8 Legionella Guidance.
2) Be installed in Table 250 copper or Durapipe SupaFLO ABS throughout laid to a minimum fall of 1:40.
3) Be provided with a borosilicate clear glass trap with manual top up facility located adjacent to the component served.
4) Minimum water seal depth of 200mm or twice the fan static pressure whichever is greater.
5) Discharge from the trap, via a tundish and air gap, to the condensate drainage pipework system.

M3-7-12 CENTRIFUGAL FANS

The AHU shall include for centrifugal direct drive supply and extract fans as detailed on the tender drawings and shall be.

1) Direct drive assembly.
2) Fan and motor shall be mounted on a full inertia base complete with 98%+ efficient spring AV mounts.
3) Flexible connections to be provided between fan and AHU.
4) Be selected based on pressure development of stated ESP and assuming all filters are at dirty condition.
5) Be selected based on 110% of stated design flow rate.
6) Be centrifugal double inlet double width fully welded backward curve aerofoil blade type.
7) Have a maximum fan tip speed of 2,500 RPM.
8) Minimum overall system efficiency as required to meet EU Regulation 1253/2014 or whichever is the greater. Overall system efficiency shall be the product of fan efficiency, drive efficiency, motor efficiency and inverter efficiency.

   For clarity, system efficiency = fan efficiency X drive efficiency X motor efficiency X inverter efficiency.
9) Fan discharge shall be complete with a flexible nylon (WRC Approved Material) reinforced connection.
10) Have drains at bottom of the scroll.
11) All fans sealed for life bearings shall be guaranteed for a life of 50,000 hours.

Each motor shall:

1) Have a motor efficiency of at least IE3 only. For clarity, although IE2 fans and variable speed drives are permitted in the Ecodesign Directive, where the fan motors are inverter speed controlled the motors shall be IE3 standard.
2) Selected for frequency operation of between 45 and 70 Hz at peak design flow rate.
3) Be selected for maximum fan absorbed power plus 10%.
4) Suitable and selected for a 400 volt and 3 phase supply.
5) The inverters shall be of the same range/manufacturer and shall be supplied and installed by the Controls Contractor.
6) Install a suitable lockable 3 phase isolators on the outside of the unit to feed each motor, along with power cables connected from the isolator to each motor. Power cables shall be wired in low smoke zero halon (LSZH) cables.

General requirements for fan and motor assembly:

1) Shall be positioned on its own channel base frame.

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2) Guards shall be provided to offer full protection to all exposed components inside the fan section where there are moving parts so that the AHU can be safely operated with the access door open during diagnostic testing.

M3-7-13 ACCESS SECTIONS AND FLOORS

In the positions shown on the drawing(s) and schedule and as required for inspection purposes, access sections shall be provided. These shall be of 500mm minimum in length.

The internal floors of the AHU shall be manufactured to support a maintenance fitter's weight and this weight should be taken to include a fitter and tool kit. Therefore, all access sections shall be provided with a reinforced floor.

The reinforced flooring shall be constructed using galvanised steel checker plate except within access sections downstream of cooling coils and humidifiers where 316L stainless steel checker plate shall be installed.

M3-7-14 AHU TESTING

All AHUs shall be fully assembled to ensure correct fit of all components including (motor control panels, inverters, containment and wiring etc.) and inspection at the AHU supplier's works before being broken down for delivery to site.

The air handling unit shall be designed such that an air leakage rate, under negative and positive pressure, is less than figures detailed in the earlier 'General Installation Clauses – Ductwork' specification section, 'Standards Applicable' and the previously given table.

AHUs being tested shall be complete assembly shall include all actuators, sensors, electrical containment, electrical wiring and filters so that the units are fully complete and ready for delivery.

Full testing of one air handling unit of each type and airflow, which for tender means testing:

Each AHU test shall include the following at the AHU manufacturer's factory or agreed test facility:

1) Electrical installation testing.

1) Operation of fans proving the fan duty against the specified external resistance imposed by a suitable damper assembly, test rig to be provided by the AHU supplier.

2) All filters shall be tested to confirm the integrity and filter efficiency is maintained, including the frame sealing. Filter manufacturer's proprietary frames shall be used.

3) Verification of calculated fan energy consumption (complies with EU No. 1253/2014). Factory tested to prove compliance with current requirements of EU Regulation 1253/2014 – this is required to avoid delivery of non-compliant AHUs.

4) All tests to be witnessed by up to 4 design team members plus any relevant construction team members. Test certificates shall be provided ready for signing by the nominated witnessing person. For tender purposes the nominated person shall be the CPW nominated representative.

Following successful factory test, the units shall be dismantled for delivery to site, into sections no greater than 4.0m long or as agreed for craning. The AHU manufacturer shall include for delivery, offloading and assembly of the AHUs on site.

Once fully assembled on site, with all power and controls wiring completed, all air handling units shall be fully pressure tested to prove the AHUs meet the 'AHU Casing Construction' standards previously listed.

M3-8 DECENTRALISED LOCAL EXTRACT SYSTEMS

As detailed on the tender drawings small single extract fans shall be installed. Ventilation rates shall be as per the Design Standards / Schedules.

The fans shall:

1) CE Certified and Marked.

2) Incorporate DC motors to minimise energy consumption.

3) Include sealed for life bearings.

4) Include integral backdraught dampers / shutters.

5) Include thermally protected motors.

6) Be provided with at least two speed operation of 'low speed' and 'boost'. Low speed shall normal operating mode during occupied hours, when occupancy is detected the 'boost' shall be activated.

7) Occupancy shall be detected by the passive infrared detectors.

8) Include fan status LED monitoring panel.

9) The fans shall discharge to outside via local exhaust louvres via the side wall at ground floor and through the roof and first floor.

10) Each fan assembly shall have local motorised isolation damper to seal the system when the fan is not running.

Local extract fans shall be manufactured by one of the manufacturers listed in the schedule at the end of this section.

M3-9 KITCHEN EXTRACT SYSTEM

The kitchen extract ventilation systems shall provide extract ventilation to the areas detailed on the tender drawings shall:

- Be fully compliant with Ecodesign Directive for fans, particularly Commission Regulation EU No. 327/2011 requirements. It is fully understood that the kitchen extract fans do not need to comply with EU No. 327/2011 however compliance is a requirement on this project to maximise energy efficiency.
- Have a motor efficiency of at least IE3 only. For clarity, although kitchen extract fans do not need to comply with being IE3 standard this is a requirement on this project to maximise energy efficiency.
- Be supplied and installed with the control gear and local electrical wiring necessary to provide fully functional system.
- Have fan casings manufactured from heavy gauge corrosion resistant steel complete with internal high density acoustic treatment generally to the same overall construction standards as the main ventilation air handling units.

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- Be bifurcated design with the fan motor out of the airstream.
- Be fully suitable for continuous operation at a temperature of 60°C.
- Be fully suitable for continuous operation at 100% humidity.
- Be fire rated to ensure the whole ventilation installation is certified as fire rated.
- Have 98% efficient anti-vibration mountings.
- Be fully suitable for their intended locations.
- Shall be fully compliant with BESA DW 172.
- Be manufactured and installed in accordance with BS9999 and comply with the performance stated within BS 476 Part 24 (ISO 6944). The fire resistance from either within or outside the duct shall be a minimum of two hours.
- Fire rated fan shall be a Type A and Type B certified fire system compliant with performance characteristics to BS 476, Part 24 (ISO 6944) of: STABILITY INSULATION AND INTEGRITY.
- Include motorised damper to seal the building when the fan is not running.
- Provided with a local control and monitoring panel to provide fan enable, fan speed adjustment, fan run status lamp, fan trip lamp and low airflow lamp.
- Linked to the supply air fan so that neither fan runs in case of either fan failing / linked to hold off the supply fan if the extract fan has failed.

Kitchen extract fan shall be manufactured by one of the manufacturers listed in the schedule at the end of this section.

M3-10 LOCAL PLATE HEAT EXCHANGER HEAT RECOVERY VENTILATION UNITS

Provide local heat recovery ventilation units as detailed on the tender drawings, provided in the schedules and below:

- Heat recovery ventilation units shall be manufactured from sheet steel with 50mm double skinned infill panels construction for low noise levels and shall include high efficiency heat plate heat exchanger, supply and extract filters, automatic summer bypass, inverter driven variable fan speed controls, motorised dampers and heating coils.
- Each unit shall be acoustically treated to achieve noise breakout in accord with 35dBA within the areas below. Acoustic performance must accord with requirements of the Project Acoustician. Factory testing of a unit to the satisfaction of the Project Acoustician shall be undertaken.
- Utilise low energy, high efficiency fan / motor assemblies with sealed for life bearings.
- Fans shall be speed adjustable.
- Have a minimum thermal efficiency of 75%.
- Be complete with grade G4 bag filters.
- Be constructed with removable panels, from below (bottom access) allowing full maintenance access and services distribution through the void. Unit handing shall be determined by the coordinated installation drawings.
- Be provided with integral controls with BMS enable and fault.
- Power supplies to each unit shall be taken from the MCCP and shall be installed by the Controls Specialist.
- Ensure the heat recovery / heat exchanger section of the unit is fully bypassed when night time purging is beneficial.
- Complete with motorised shut off dampers shall be installed on intake and exhaust ductwork. Full access dampers shall be provided for future maintenance.
- Fully weatherproof construction if mounted outside.
- Intake and exhaust air shall be as detailed on the tender drawings.
- Be provided with modulating supply and extract fans for energy saving measures via spatial combined CO_2/temperature sensors.
- Local wall mounted fascia provided to indicate fan status (run and fail) and to provide user boost facility (final positions to be agreed).
- Condensate pump shall be provided if condensate drain provided and insufficient natural gradient can be achieved for the natural condensate drain. Condensate shall be trapped using a HepVO dry trap and air break prior to terminating at local above ground drain.

M3-11 ATTENUATORS

Attenuators shall be provided as indicated on drawings and fully in accordance with the Design Standards of this specification to limit noise transmission and noise breakout such that the maximum design room noise levels are satisfied.

Ensure that all attenuators are installed in accordance with manufacturer's instructions and that all necessary transformation pieces are included for at 30 degrees maximum.

All attenuators shall be:

- Vapour sealed.
- Fully self-supporting.
- Constructed from same material as rest of ductwork (i.e. galvanised steel for galvanised steel ductwork).
- Thermally insulated.
- The attenuators shall be inspected for dirt ingress when manufactured, cleaned, sealed during transit and prior to installation.

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- All attenuator manufacturer's shall under write the acoustic performance of the attenuators and hold professional Indemnity Insurance (to the project's level) for 12 years from practical completion.

Attenuators shall be manufactured by one of the manufacturers listed in the schedule at the end of this section.

M3-12 VOLUME CONTROL DAMPERS

All volume control dampers shall be installed in the positions where required to allow the proportional balancing of each system. After the balancing and commissioning of the systems all quadrants arms/control knobs shall be locked and permanently marked to aid the system to be re-balanced after maintenance. Aerofoil opposed blade type dampers shall be used, with quadrant lockable handles.

All volume control dampers shall be compliant with Ductwork Standards section of this specification.

M3-13 GENERAL SUPPLY DIFFUSERS AND EXTRACT GRILLES

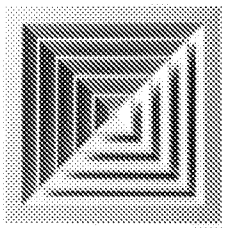
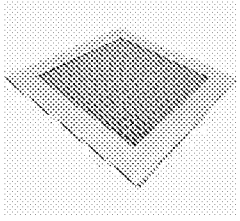
The designer shall liaise with the project architect to agree all grilles and diffusers based on the currently agreed requirements.

All diffusers and grilles shall comply with the following:

1) All grilles and diffusers shall be easily cleaned and removable.
2) Be provided with a side entry spigot plenum boxes (supply and extract). Top entry shall only be accepted in exceptional circumstances and with written agreement of Engineer.
3) Plenum boxes shall be acoustically lined where necessary.
4) Provided with integral opposed blade volume control dampers (unless a duct mounted VCD is provided that solely serves the grille / diffuser).
5) Installed fully in accordance with the manufacturers recommendations.
6) Be finished in a powder coat finish, RAL colour to be agreed with Architect.
7) All supply and extract terminals shall be sized and selected with a maximum velocity of 2.0m/s or lower to meet the design noise limit criteria.
8) All extract grilles to be provided with hinged and shoot bold retained removable cores, plenums and volume control dampers.
9) Selected to suit the type of ceiling.
10) Positions to be co-ordinated with light fittings and all other services.
11) Unless the ductwork design is deemed self-balancing (and agreed by the Engineer) all plenum boxes shall be provided with volume control dampers. Consideration must be given to access to the dampers so pull cord adjustment shall be required to some plenum boxes.
12) Four way blow louvre faced diffusers to all areas including but not limited to offices, meeting rooms, toilets, showers and stores.

Grilles and Diffuser Types and Options – **Tendering Purposes Only**

The following table is not intended to be an exhaustive list but outlines some notional types of grilles and diffusers described for **Tendering purposes only**. It is the Contractor's responsibility to carry out a detailed design, sizing, and selection of all grilles, diffusers, dampers, and louvers.

Area/Room Served	Notional Type/Comments
4-way Blow Louvre Faced Diffuser 	For supply and extract ventilation in areas with no raised access floor voids and for bulkhead and corridor fire door air transfer paths. The Louvered faced Diffusers shall be generally installed within the room (where ceilings proposed) as part of return air path. Where a bulkhead or shadow gaps are proposed, linear bar grille shall be allowed. Where transfer ducts supply or discharge within atrium, the louvre arrangement shall be to Architect's requirements. Where required blanking plates and reduced size plenum boxes shall be provided to achieve the design throws, etc. for optimum airflow distribution.
Egg Crate Grille 	Extract only in toilets, cleaners' stores and shower. These shall not be acceptable in any other areas. Egg Crate grille Type: EGOR for greater airflows. Be powder coated finish to a RAL colour to suit Architectural requirements. Include for confirming all site dimensions prior to commencing manufacture. Be selected to achieve NR levels stated in design standards for the space. Colour and hole pattern to be agreed with Architect and Engineer prior to manufacture.

All the grilles, diffusers shall be selected and coordinated with Architect's ceiling grid, electrical, acoustic and specialist equipment with all diffuser grilles RAL colours agreed with the Architect prior to procurement.

Supply diffusers and extract grilles shall be manufactured by one of the manufacturers listed in the schedule at the end of this section.

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M3-14 DUCTWORK CONSTRUCTION

M3-14-1 GENERAL

All ductwork systems shall be installed and erected in full accordance with 'General Installation Clauses – Ductwork' of this Specification.

Note – some requirements of this section supersedes standards detailed in BESA DW and TR Guides.

The principal duct runs shall be located below the structure in order to evenly distribute weight onto the building structure all in accordance with Structural Engineer's requirements.

Where ductwork passes through the insulation line of the building a thermal break within the ductwork shall be provided. This shall be via a change in material (i.e. galvanised ductwork to suitable plastic (PPs) thermal break) with fully overlapped insulation to maintain the thermal integrity of the envelope.

M3-14-2 FIRE RATED DUCTWORK

Fire rated ductwork shall be provided as detailed on the tender drawings and for all kitchen supply and extract ductwork to meet the following criteria:

- All fire rated ductwork, including plant, brackets, fixings and supports, shall be fully fire rated to achieve 2 hours fire resistance in-accordance with DW 172. Fire rated ductwork as shown on the drawings shall be manufactured and installed as described within Method 3, BS 5588, Part 8 and comply with the performance stated within BS 476 Part 24 (ISO 6944). The fire resistance from either within or outside the duct shall be a minimum of two hours.
- The ductwork installation shall be a Type A and Type B certified fire system i.e. proprietary fire rated ductwork system and performance characteristics to BS 476, Part 24 (ISO 6944) of: STABILITY INSULATION AND INTEGRITY.
- The Fire Rated Ductwork Specialist shall detail, manufacture, delivery, install including all support systems and pressure test the system as described.
- Access doors shall be provided at a minimum of 3 metre centres.
- Fire dampers are not be installed or be required on this system.
- All connections onto Kitchen and dishwasher canopies are to be installed with a fall over the last 3 metres laid towards the canopies. The 3 metres of ductwork prior to connecting to the canopies shall also be installed in 316 stainless steel.
- Kitchen discharge shall be a high velocity cowl with internal drain manufactured from stainless steel. Submission is to be presented to the Services Engineer for approval/acceptance.
- Ductwork located in the same fire zone as the kitchen (i.e. above kitchen ceiling if part of same zone) does not need to be fire rated and shall be galvanised ductwork to 'Standard Sections – Ductwork' requirements.

M3-14-3 LOUVRES

All external louvers shall be provided and installed by the Main Contractor for final connection by the Mechanical Contractor. Mechanical Contractor shall coordinate with the Main Contractor to ensure the correctly specified louvers are used i.e. grade of weather protection, materials, pressure drops, airflow volume, etc.

The louvers shall comply with category 'B' rain defence and shall have minimum of 50% free area, providing pressure drop of 10 to 15 Pa on intake and 30 to 35 pa on exhaust with maximum velocity of 1.7m/sec.

The Main Contractor shall include for:

- Blanking off un-used sections of louvre with pre-insulated sandwich powder coated steel panels (proprietary system manufactured by louvre manufacturer) to the fabric thermal performance criteria for the plantroom walls (i.e. U value and air tightness). Details of unused sections of louvres to be provided by the Mechanical Contractor.
- Full co-ordination of louvre positions / connection arrangements, details to be provided by Mechanical Contractor.
- All blanking plates shall be carried out prior to the Building Regulations Part L air leakage testing for the building.

M3-15 FLEXIBLE CONNECTIONS

Flexible ductwork shall be in accordance with 'General Installation Clauses – Ductwork' section of this Specification.

M3-16 FIRE AND COMBINATION FIRE & SMOKE DAMPERS

Fire dampers and combination fire and smoke dampers shall be in accordance with 'General Installation Clauses – Ductwork' section of this Specification.

The supply, installation and commissioning fire and combination fire & smoke dampers as necessary for compliance with the latest fire strategy drawings, fire engineering report, the approval of the Fire Advisor and Building Control shall be included.

M3-17 THERMAL INSULATION

All supply and extract ductwork, shall be thermally insulated in accordance with 'General Installation Clauses – Thermal Insulation' section of this Specification.

M3-18 TESTING AND COMMISSIONING

Each system shall be tested and commissioned as described within section 2 of this specification.

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APPENDIX – MAIN VENTILATION PLANT / EQUIPMENT SCHEDULES

AIR HANDLING UNIT		
Reference	AHU 1 Kitchen Supply Unit	
Component	Description	Condition
Location	Refer to tender drawings.	
Duty	To be determined by Contractor.	
Dimensional restrictions	Maximum overall height including support base. Maximum overall length. Maximum overall width.	1100mm. As required. As required.
Components in direction of air flow. Note 1 – Air side pressure drops are maximum permitted values that may need to be lower to comply with EU No. 1253/2014 as detailed earlier.		
SUPPLY SIDE		
Motorised Inlet Damper	As detailed in main section.	Required.
Access Section	As detailed in main section.	Required.
Panel Filter	As detailed in main section.	G4.
Direct Drive Supply Fan.	Airflow and ESP.	To be determined by Contractor.
Access Section	As detailed in main section.	Required.
Heating Coil (Electric)	On Coil. Off Coil.	-5° C db +16°C db.
Access Section	As detailed in main section.	Required.
Bag Filter	As detailed in main section.	F7.
Comments.	Unit to be fully protected for coastal / saline environment.	
Manufacturer: As listed in the Design Standards Preferred Manufacturers Schedule OR • Nuaire. • Dakin Limited. • Exhaft Air Handling Units. • Buningham Air Conditioning. • Carrier (UK Climate). • TROX UK Limited.		

KITCHEN EXTRACT FAN	
Reference	KEF 1
Size and Type	Bifucated.
Duty	To be confirmed by design contractor.
Location	Externally on flat roof.
Accessories	Flexible connections. Wall mounted support brackets.
BMS Interfaces	Enable signal. Run signal. Fault signal. Airflow Failure signal. Variable speed control.

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KITCHEN EXTRACT FAN	
	AHU interlock.
Comments	Unit to be fully protected for coastal / saline environment.
Manufacturer: As listed in the Design Standards Preferred Manufacturer Schedule OR • Nuaire • VES Ashway • Vent-Axia • Xpelair	

HEAT RECOVERY UNIT	
Reference	HRU 01 Laundry
Location	External flat roof.
Serving	General ventilation for Laundry Area.
Manufacturer	Nuaire
Type	XBC
Duty – supply and extract airflow	To be confirmed by design contractor.
Maximum Noise Level	See Design Standards and Acousticians Report
Power Supply	To be confirmed by design contractor.
Dimensions/ Weight	To be confirmed by design contractor.
BMS Interface	System enable. System running. Supply filter dirty. Extract filter dirty. Supply fan fault. Extract fan fault. Fire alarm interface / shutdown.
Comments	Electric heater battery to be provided. Manufacturers packaged control system acceptable. Unit to be fully protected for coastal / saline environment.
Manufacturer: As listed in the Design Standards Preferred Manufacturer Schedule OR • Nuaire • Vent-Axia • Systemair	

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Section M5

Cooling Systems

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M5-1 GENERAL REQUIREMENTS

The cooling systems required for this project shall be as follows:-

1) A Variable Refrigerant Flow (VRV) system to satisfy building cooling and heating requirements, the system to comprise all plant, refrigeration distribution and control as detailed on design drawings and following clauses.
2) Local DX cooling systems to individual spaces such as IT hub/comms rooms, drug and clinical stores all as detailed on design drawings and following clauses.
3) All outdoor units to be fully protected for coastal / saline environment.

M5-2 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS			
BPV	Automatic Bypass Valve	EU	European Union
CS	Commissioning Station / Set	MEPS	Minimum Energy Performance Standard
DAC	Dry Air Coolers	PHX / PHE	Plate Heat Exchangers
DPR	Stabilising Differential Pressure Regulators	SEPR	Seasonal Energy Performance Ratio
DX	Direct Expansion	VFC	Volt Free Contacts
EER	Energy Efficiency Ratio	VRF	Variable Refrigerant Flow
ESEER	European Seasonal Energy Efficiency Ratio	VRV	Variable Refrigerant Volume

M5-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred pipework material and standard or utilise one of the alternative materials and standards of construction listed in the section 2A clause 2A-1-4 detailed earlier in this specification. Agreed alternative materials for the installation from the preferred standard material and standard of construction is:

No deviation from the section 2 preferred material requirements.

Section 2A provides all necessary details on pipework and valve materials and performance requirements that apply to this section.

M5-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
ASTM B280 Standard specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	BS EN 14825 Air conditioners, liquid chilling packages and heat pumps for space heating and cooling. Testing and rating at part load conditions and calculation of seasonal performance
BS EN 378 Refrigerating systems and heat pumps. Safety and environmental requirements	BS EN 16297 Pumps. Rotodynamic pumps. Glandless circulators. Calculation of energy efficiency index (EEI) for stand alone circulators
BS EN 515 Aluminium & Aluminium Alloys	BS EN ISO 14414 Pump system energy assessment
BS EN 1397 Heat exchangers. Hydronic room fan coil units. Test procedures for establishing the performance	BS ISO 817 Refrigerants – Designation and safety classification
BS EN 12102 Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors. Determination of sound power level	Building Engineering Services Association (BESA) RAC80 Design specification for the application of DX air conditioning and heat pump equipment
BS EN 12735 Copper and copper alloys. Seamless round tubes for air conditioning and refrigeration	Building Regulations
BS EN 13831 Closed expansion vessels with built-in diaphragm for installation in water.	BSRIA Commissioning Codes
BS EN 14511 Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors	CIBSE Commissioning Codes
Pressure Equipment Regulations & amendments.	CIBSE Design Guides
	F-Gas Regulations

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Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M5-5 SCOPE OF WORKS

The following brief description identifies those systems required for installation on this project. Comprehensive system requirements shall be detailed in the subsequent clauses of this specification together with schematic and design drawings.

The variable refrigerant flow direct expansion refrigerant installation shall include for all necessary tools, labour, materials and equipment to design, supply, install, commission and put into operation the comfort cooling services, including the following:

1) Heat pump external condensing units.
2) Multiple indoor heating and cooling units, each indoor unit shall be capable of heating or cooling independently of the other indoor units.
3) Interconnecting three pipe refrigeration pipework with branch valves and refrigerant controllers.
4) Thermal insulation, weather and solar treated where exposed.
5) Interconnecting electrical power and control wiring.
6) Local remote controls and control interfaces required by the BMS to full integrate with the system.
7) Pressure testing, evacuation and charging.
8) Commissioning.
9) Witnessing of all testing and commissioning.

The DX local cooling shall include for all necessary tools, labour, materials and equipment to design, supply, install, commission and put into operation the local cooling systems, including the following:

1) External condensing units.
2) Indoor cooling only units.
3) Interconnecting refrigeration pipework with branch valves and refrigerant controllers.
4) Thermal insulation, weather and solar treated where exposed.
5) Interconnecting electrical power and control wiring.
6) Local remote controls and control interfaces required by the BMS to full integrate with the system.
7) Pressure testing, evacuation and charging.
8) Commissioning.
9) Witnessing of all testing and commissioning.

The following are the requirements that are common to all of the systems described above:

1) Liaison with other trades on site.
2) Copies of Operating and Maintenance instruction manuals including a 'brief description' of services and fault finding information list of spares, emergency telephone Nos. etc.
3) Full user instruction, both written and in the form of demonstrations.
4) All primary and secondary support systems to install the services.
5) Complete electrical installation works associated with this Section of the Specification including all cabling, local isolation and protective devices.
6) Development of the Consultants drawings and detailing from the base tender information to full construction standards as detailed previously. This shall include responsibility for the following areas:-
    a) Support systems/brackets for all services.
    b) Expansion and contraction within the system networks.
    c) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.
    d) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents.
    e) Development of the controls specification for the hardware, software, power, controls wiring and all associated equipment.

M5-6 DIRECT EXPANSION REFRIGERATION SYSTEMS

All refrigeration systems shall be supplied, installed, tested and commissioned fully in accordance with the requirements of the respective manufacturer and installed by a manufacturer certified / approved Refrigeration Specialist.

The Refrigeration Specialist shall select the DX units to be operational and compatible with the maximum distance or runs of the refrigeration pipework between indoor and outdoor units fully in accordance with equipment manufacturer's best practice recommendations.

M5-6-1 LOCAL DIRECT SPLIT SYSTEMS

Server Rooms, Hub Rooms, IT active rack and lift motor rooms to have individual DX systems in each all room, which meet the following criteria:

1) Server Rooms shall be provided with N+1 basis (one total spare unit after loads are met) and smaller Hub Rooms shall only be designed on an N basis (no spare unit).

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2) Each system shall provide the required sensible cooling during design external ambient conditions of 35°C and maintaining the room to 25°C ± 2°C db maximum for the hub rooms. Other areas to meet manufacturer's requirements.
3) Cooling using refrigerant R410a.
4) Outdoor units not to exceed NR65 at 1 metre.
5) Every system shall be designed and certified to have an EER compliant with the non-domestic building services compliance guide or to satisfy EPC requirements.
6) Wall mounted LCD remote controller (one per system).
7) Gravity drains if possible. If not possible integral condensate pump, one per indoor unit. If this pump should fail for any reason, the associated unit shall shut down to prevent flooding.
8) BMS signal from the units to monitor failure/maintenance requirements.
9) BMS monitoring of room temperature for early fault indication.
10) Lowest evaporating temperature = minus (-) 5°C.
11) Condenser selection ambient temperature = plus (+)35°C dry bulb.
12) Year round operation (winter start kit).
13) Refrigerant lines and power/control cabling distribution upon galvanised cable try. Electrical cabling standards as per Controls Section.
14) Room noise criteria and external noise criteria as per schedule.
15) LCD set point controller (wall mounted @ FFL + 1500 – one per system) enabling interrogation of the equipment for servicing procedures.
16) Duty/standby/auto changeover via the BMS in the event the DX system should fail the standby system shall operate. The BMS shall also rotate which DX system is duty and which is standby on a week by week basis to ensure even wear of the units.
17) Selected to achieve an Energy Rating of 'A' for each system.

M5-6-2 VARIABLE REFRIGERANT FLOW SYSTEMS

Variable refrigerant flow systems shall be provided as detailed elsewhere. The system shall be capable of providing simultaneous heating and cooling to each room as detailed on the tender drawings and to meet the following criteria:

1) Each Room shall be provided with one or more internal units to meet the room environmental requirements. These shall have an electronic valve to control refrigerant flow rate in response to the load variation in the conditioned space. The expansion valve shall be controlled by an integral computerized PID control system to maintain design parameters.
2) Use refrigerant R410a.
3) The system shall be designed and certified to have an EER compliant with the non-domestic building services compliance guide or to satisfy EPC requirements.
4) Wall mounted LCD remote controller, branch controller and central control system with BMS back net connections.
5) Integral condensate pump, one per indoor unit. If this pump should fail for any reason, the associated unit shall shut down to prevent flooding.
6) BMS signal from the units to monitor failure/maintenance requirement.
7) Lowest evaporating temperature = minus 5°C.
8) Condenser selection ambient temperature = 35°C dry bulb.
9) Year round operation (winter start kit).
10) Refrigerant lines and power/control cabling distribution shall be installed upon galvanised cable tray. Electrical cabling standards shall be as detailed in the Controls Section of this Specification.
11) LCD set point controller (wall mounted @ FFL + 1500 – one per system) enabling interrogation of the equipment for servicing procedures.
12) Selected to achieve an Energy Rating of 'A' for each system.

M5-6-3 OUTDOOR UNITS

The units shall be:

1) Air-cooled type.
2) Outdoor units not to exceed NR65 at 1 metre.
3) Heat exchanger coils shall be manufactured from aluminium tubes and aluminium fins to reduce corrosion.
4) The unit casing shall be manufactured from galvanised steel with polyester powder coated finish.
5) The air outlet shall have plastic fan guards.
6) The capacity control of outdoor units shall be via inverter driven compressor(s) electronically controlled and capable of changing speed linearly by sensing operational temperatures, pressures, ambient temperature and monitoring requirements for the indoor units.
7) Each unit shall be complete with:-
   a) Electronic expansion valve.
   b) High (manual reset) and low (automatic reset) pressure switches.
   c) Fan motor safety thermostat
   d) Over current relay
   e) Inverter overload protection

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f) Liquid and gas shut off valves

g) A short re-cycling guard timer.

h) The access to the internal components for maintenance purposes shall be by removable panels.

i) Shall be suitable for a 400V, 3phase,50Hz electrical supply

j) CE certified.

8) The condensing units shall be supported to avoid preventing routine building maintenance and hence shall be mounted on one of the following:

a) Wall mounted condensing units shall be fixed using manufacturer's wall bracket supports. Sufficient space shall be left below the units for all necessary access and to avoid leaves from being drawn into the condenser coils.

b) Floor mounted supports shall be purpose made support systems as available from Roof Pro and Big Foot Support Systems.

c) Roof mounted shall be either mounted on weather proof precast concrete plinths provided by the Main Contractor or on purpose made support systems as available from Roof Pro and Big Foot Support Systems.

d) Where condensing units are supported above flat roofs the support frames shall be demountable one support at a time and remain structurally safe and supported a minimum of 450mm clear above the roof finish to allow the repair and replacement of the roof finish in the future without impacting on the refrigeration installation.

M5-6-4 INDOOR UNITS

Each unit shall be:

1) Manufactured from galvanised steel plate back plate or heavy duty plastic frame and support frames with heat resistant plastic casing. The casing / fascia colour shall be ivory white.

2) The fan shall be multi blade cross flow type, statically and dynamically balanced to ensure low noise and vibration free operation.

3) Supply air shall be through the louvers situated on the front façade of the unit. Allowance shall be made for the manual adjustment of directional vanes for horizontal air discharge. Facility shall be provided to set the vertical discharge or select auto swing to ensure the required distribution of air flow.

4) The heat exchanger coils shall be manufactured from copper tubes and aluminium fins.

5) The air filters shall be incorporated within the unit and shall be washable resin net type.

6) Where the unit is located within a suspended ceiling a low profile dedicated decoration panel shall be provided for each unit. The decoration panel shall incorporate the return air grille and supply air louvers. A facility shall be provided to automatically swing the supply air louvers or lock them at a desired angle between 0° and 60° to ensure even distribution of the airflow.

7) Where the unit is concealed within a suspended ceiling void the unit shall manufactured from galvanised steel plate and shall be fully insulated. Provided with the following:

a) Provided with ductwork connection for supply and return ducts.

b) Facility shall be provided for duct connection for introduction of the fresh air in the unit and branch ductwork from the unit.

M5-6-5 CONDENSATE PIPEWORK

All condensate pipework shall be installed as detailed in the Above Ground Drainage section.

M5-6-6 REFRIGERANT PIPEWORK

The system shall be complete with all interconnecting refrigeration pipework between each indoor evaporator and each condensing unit that meets all of the following requirements:

1) The pipework shall be of refrigerant quality copper tube.

2) Fittings and joints shall be kept to a minimum with all bends being long radius as made using proprietary pipe bending equipment.

3) All pipework shall be clean, dehydrated and sealed.

4) Pipework shall be stored under dry conditions.

5) Any pipework found to be stored without the end caps should be rejected.

6) Where sections are cut from a new coil any remaining lengths must be re-sealed.

7) During the installation if the system has to be left unattended for any purpose whatsoever, the openings in the systems must be securely sealed.

8) Flare joints shall be kept to a minimum i.e. final terminations only, with all other site joints being brazed on site.

9) All brazing shall take place when the pipework is being continuously purged with oxygen free dry nitrogen to ensure no moisture enters the system and also preventing formation of oxides of copper. When the pipework is not being directly worked on all ends of the pipework shall be capped off.

10) Any joints required shall be correctly swaged and any pipework being cut shall be done using sharp cutting wheels with any resulting burrs removed to return the pipework to its original dimension.

11) If the Design Engineer has any reason to believe that any of the above has not been carried out he/she shall require the Refrigeration Contractor to degas, and cut out any suspect joints or fittings for inspection. If any joints or fittings are found to be burred, contaminated or in any way not be good installation practice then he shall instruct the Refrigeration Contractor to remove the entire circuit for reinstallation at the Contractor's own cost.

12) Each refrigeration circuit shall be pressure tested to 1.1 times the working pressure for 24 hours. Any drop in pressure shall require the Contractor to locate any leaks and make good.

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13) Each circuit shall then be triple evacuated for de-hydration using oxygen free dry nitrogen as the purge gas.

14) During the final evacuation each circuit must be shown to hold vacuum for 1 hour prior to charging.

15) The vacuum shall be broken with oxygen free nitrogen on the first two occasions and with any necessary refrigerant charge on the third.

16) The Refrigeration Contractor shall inform the Engineer of the amount of refrigeration used to charge the system, and shall allow in his tender to return to site during design ambient conditions to check the performance of the refrigeration plant against its design intent.

17) All suction and vacuum lines shall be insulated as detailed in section 2D.

18) The Contractor shall ensure any headers/manifolds are insulated with oversize insulation to provide a vapour seal.

19) The refrigerant lines shall be installed in fully accordance with the equipment manufacturer's recommendations.

20) The route of refrigerant lines and condensate services shall be agreed on site, prior to installation commencing.

21) All refrigerant pipework shall be mounted on galvanised cable tray where concealed or external and within white PVC refrigeration services encasement offered by the split system manufacturer where exposed.

22) Pipework passing through fire resisting walls and ceilings shall be fitted with propriety fire stops.

23) Consideration shall be given for the need to provide within the pipework adequate flexibility for thermal movement.

M5-7 TESTING AND COMMISSIONING

Testing and commissioning shall be carried out fully in accordance with Section 2 of this Specification. All commissioning generally shall be completed by the Commissioning Specialist with the manufacturers commissioning their own plant:

1) DX and VRF systems

All refrigerant Systems shall be commissioned twice in two separate visits. The first commissioning visit shall be upon completion of the installation and shall include for charging the system with refrigerant gas and satisfactory setting of the system to work. A second commissioning visit to site, during the summer months when the ambient is above 26°Cdb, to undertake any necessary final adjustments to the control settings or refrigerant quantities within the system, under actual design loads.

All commissioning shall be undertaken in accordance with the relevant CIBSE Codes of Practice.

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APPENDIX – EQUIPMENT SCHEDULES

DIRECT EXPANSION COOLING SPLIT SYSTEMS									
Ref	Indoor Location	Sensible Cooling Duty (kW)	Heating Duty (kW)	Control Temperature (°C +/-1K)	Indoor Noise Rating (NR)	Indoor Unit Type	Local Control	Fan Speed L/M/H	Comments
1	Server Room	5 kW	N.A.	As Section 6	As Section 6	Wall Mounted	Yes	L	

Design Parameters

1) BMS interface for individual set point adjustment and system fault.
2) Selected for an external ambient of 35°C dry bulb.
3) Outdoor units not to exceed NR65 at 1 metre.
4) Condensate pump to be included for within tender return
5) Outdoor units to be fully protected for coastal / saline environment.

Manufacturer:
- Daikin
- Mitsubishi

VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS									
Reference	Indoor Location	Sensible Cooling Duty (kW)	Heating Duty (kW)	Control Temperature +/- (°C +/- 1K)	Indoor Noise Rating (NR)	Indoor Unit Type	Local Control	Fan Speed L/M/H	Comments
1	Laundry	Allow 200 W/m2 **(1)**	See Note 1	As Section 6	As Section 6	Ceiling Cassette	Yes	L	
2	Kitchen	Allow 200 W/m2 **(1)**	See Note 1	As Section 6	As Section 6	Ceiling Cassette	Yes	L	
3	All dayrooms / household / dining / treatment / staff rooms etc	Allow 120 W/m2 **(1)**	See Note 1	As Section 6	As Section 6	Ceiling Cassette	Yes	L	
4	Garden Room	Allow 120 W/m2 **(1)**	See Note 1	As Section 6	As Section 6	Wall Mounted	Yes	L	

Design Parameters

1) To be determined and confirmed by the design contractor with tender submission.
2) BMS interface for individual indoor units and outdoor units via MODBus to provide at least set point adjustment, time scheduling and indoor & outdoor unit fault.
3) Selected for an external ambient of 35°C dry bulb.
4) Outdoor units not to exceed NR65 at 1 metre.
5) Condensate pump to be included for within tender return.
6) Complete with Central Master Controller and Energy Data Retriever Facility.
7) Outdoor units to be fully protected for coastal / saline environment.

Note location of external condensing units and lengths of pipework required from compound to the building.

Manufacturer:
- Daikin
- Mitsubishi

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Section M6

Above Ground Drainage

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M6-1 PIPEWORK INSTALLATIONS

Supply, install and commission the pipework installations as detailed on the Tender drawings and within this specification, employing skilled personnel to the standards described. All pipework shall be entirely suitable for operation with the particular fluids conveyed and pressures involved. Materials for specific systems are detailed in this specification section

M6-2 DEFINITIONS

Refer to section 2 for general definitions plus the following:

DEFINITIONS	
ABS	Acrylonitrile Butadiene Styrene
FCU	Fan Coil Unit
HIU	Heat interface unit
HDPE	High density polyethylene
PP	Polypropylene
PVC-C	Polyvinyl Chloride Chlorinated
PVC-u / uPVC	Polyvinyl Chloride (Un-plasticised)
Supervising Officer	Where this term is used it shall mean the person undertaking the inspection of installed work, and shall apply equally Clerk of Works or Engineer.

M6-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

M6-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BS 416 Discharge and ventilating pipes and fittings, sand-cast or spun in cast iron.	BS EN 13501 Fire classification of construction products and building elements
BS 6465 Sanitary installations	BS EN 15012 Plastics piping systems. Soil and waste discharge systems within the building structure
BS 10226 Pipe threads where pressure tight joints are made on the threads	BS EN ISO 13255 Thermoplastics piping systems for soil and waste discharge inside buildings
BS EN 681 Elastomeric Seals. Materials requirements for pipe joint seals used in water and drainage applications	BS EN ISO 15493 Plastics piping systems for industrial applications
BS EN 877 Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings	Building Regulations, in particular Approved Document Part H 'Drainage and Waste Disposal'.
BS EN 1057 Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications	BSRIA Commissioning Codes
BS EN 1124 Pipes and fittings for longitudinally welded stainless steel pipes with spigot and socket for wastewater systems	CIBSE Design Guides, in particular Guide G Public Health Engineering
BS EN 1329 Plastic piping systems for soil and waste discharge (low and high temperature) within the building structure	DIN 8074 Polyethylene (PE) - Pipes PE 80, PE 100 - Dimensions
BS EN 1451 Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure	DIN 8075 Polyethylene (PE) pipes - PE 80, PE 100 - General quality requirements, testing
BS EN 10467 Plastic piping systems for pressure and non-pressure drainage and sewerage	DIN EN 1519 Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Polyethylene (PE)
BS EN 12056 Gravity drainage systems inside buildings	DIN EN 12666 Plastics piping systems for non-pressure underground drainage and sewerage - Polyethylene (PE)

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

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Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M6-5 SCOPE OF WORKS

The above ground drainage system(s) installation shall include for all necessary tools, labour, materials and equipment to design, supply, install, test, commission and put into operation the sanitation and drainage services, including the following:-

1) Main gravity domestic soil, waste and ventilation system in PVC-u.
2) Low level branch soil and waste system in PVC-u.
3) Ventilation pipework in PVC-u
4) The fix only of sanitary appliances.
5) Plantroom mechanical waste system in cast iron and PVC-u.
6) Condensate from relief valve drainage to be in copper
7) Kitchen Waste Drainage
8) Plantroom gullies in cast iron.
9) Floor gullies for laundry in stainless steel.
10) Shower gullies & channels in stainless steel
11) Grease removal machines for Hot kitchens
12) Fire sleeves for PVC-u in metal
13) Unicollar fire protection for Vulcathene pipework.
14) All testing, witnessing hydraulic pressure tests and commissioning.
15) Any thermal insulation to avoid thermal bridging and condensation issues.
16) Any sound insulation to meet room acoustic requirements, especially in noise sensitive room – refer to room data sheets. Refer to architects/acoustic engineers technical details for information on how the acoustics are being managed.
17) Liaison with other trades on site.
18) Copies of Operating and Maintenance instruction manuals including a 'Brief Description' of services and fault-finding information list of spares, emergency telephone Nos. etc.
19) Full user instruction, both written and in the form of demonstrations.
20) All primary and secondary support systems to install the services.
21) Development of the Consultants drawings and detailing from the base tender information to full construction standards as detailed previously.
22) Support systems/brackets for all services.
23) Expansion and contraction within the system networks.
24) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.
25) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents

Items and installations **excluded** from this specification are as follows: -

1) Underground drainage.
2) Weathering of all pipework and outlets through the roof.
3) Rainwater pipework.
4) Car Park Drainage
5) Cavity Wall Drainage
6) Sanitary ware.
7) Effluent waste plant.
8) Positioning/setting out of drainage pipework
9) Detailing the boxing out and lagging of pipework.
10) Builders work
11) The design of the internal drainage within the POD
12) Access panels within walls, floors and ceiling.
13) Basement and carpark surface water drainage.
14) Foul water storage tanks and associated pumping plant.
15) Surface water attenuation

M6-6 DRAWINGS

Piping systems shown on the drawings are designed to comply with the above standards and are diagrammatic to indicate the general routing and sizes required. The drawings do not necessarily show all components in their true positions.

The Contractor shall be responsible for the proper erection of piping systems suitable in every respect for the design and application intent.

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Any alteration to equipment installation/positioning arising during construction which may alter the run and size of piping to accommodate situations shall be reviewed with the Engineer.

M6-7 GRAVITY DRAINAGE SYSTEM

The above ground drainage system shall be designed to system III of the BS and adhere to all relevant Building Regulations.

The drainage system shall be designed as a primary vented system and shall vent to atmosphere above the roof. Vertical stacks shall be located within agreed positions.

Frequency factors for usage should be as set out in the BS:

Usage of appliances K

Intermittent use, e.g. in dwelling, guesthouse, office 0,5

Frequent use, e.g. in hospital, school, restaurant, hotel 0,7

Congested use, e.g. in toilets and/or showers open to public 1,0

Special use, e.g. laboratory 1,2

All soil and waste branch pipes shall drain separately to its serving discharge stack as stated within BS. Pipework shall be rigid with no flexible connections being permitted; this shall particularly apply to WC connections.

Emphasis shall be given to ensure that the necessary pipe gradients are achieved to attain a self-cleansing velocity as set out in the Colebrook-White equation. Access doors and rodding eyes positioned for ease of maintenance and testing. Branch pipes should be laid to fall as per the recommendations within the BS.

Where applicable the lifetime home detail should be adhered to. Provision for a bathroom to be retrospectively modified from a bath to a shower, should be taken into account by the architect with regards to stack positioning; this enables the ease of changing a bath to a gully within the floor makeup.

Access door requirements are the responsibility of the architect, of which the positioning should be let known to the designer of the above ground system, so that testing arrangements are not hindered.

M6-7-1 PIPEWORK SYSTEM MANUFACTURERS

Refer to appendix for list of required manufacturers for specific systems. These manufacturers shall be included within tender returns.

M6-8 MATERIAL SELECTION

All pipework and components shall be selected from the table following in respect to the type of materials required. Deviations from materials specified shall only be permitted with the written approval of the Contract Administrator.

Where a different material is proposed via a value engineered option, acoustic and fixing allowances may need to be incorporated. These will be the responsibility of the proposer of the value engineered option.

	PIPE MATERIAL							
	PVC-U	HDPE	PP	ABS	COPPER	CAST IRON	STAINLESS STEEL	PVC-C
JOINTING METHOD								
Solvent Welded	✓			✓				✓
Electro Fusion		✓	✓					
Mechanical Coupling		✓	✓			✓		
Brazed Joints					✓			
Welded							✓	
Push Fit							✓	
PIPE STANDARDS APPLICABLE								
BS 416						✓		
BS 4514	✓							
BS EN 877						✓		
BS EN 1057					✓			
BSEN 1124							✓	
BS EN 1519	✓	✓	✓	✓				
BS EN 15493								✓
DRAINAGE SYSTEM TYPE								
Domestic	✓	O	X	X	X	O	O	X
Laboratory	X	O	✓	X	X	X	O	X

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	PIPE MATERIAL							
	PVC-U	HDPE	PP	ABS	COPPER	CAST IRON	STAINLESS STEEL	PVC-C
JOINTING METHOD								
Solvent Welded	✓							✓
Electro Fusion		✓	✓					
Mechanical coupling		✓*	✓*			✓		
Brazed joints					✓			
Welded							✓*	
Push-fit							✓**	
PIPE STANDARDS APPLICABLE								
Plantroom hot water	X	X	X	X	X	✓	O	X
Plantroom cold water	✓	O	X	X	X	X	X	X
Commercial Kitchens	X	X	X	X	O	X	✓	X
Domestic Kitchens	✓	X	X	X	X	X	X	X
Cooling coil condensate	X	X	X	O	✓	X	X	X
Commercial Infrastructure	O	O	X	X	X	✓	X	X
Enclosed Car Park	X	O	X	X	X	✓	X	X
Vertical distribution in multi-storey building	O	O	X	X	X	✓	X	X
Sound attenuated required	X	O (DB20)	X	X	X	✓	X	X
Safety valve drainage	X	X	X	X	✓	X	X	X
Sump pumped mains	X	X	X	O	✓	X	X	X

Key

X	Shall not be used.
✓	Default material / jointing system, shall be included at Tender and used for installation.
O	May only be used when specifically allowed in particular section of this specification.
*	Mechanical coupling jointing only to be used where pipework is installed below laboratory benching.
**	Push fit only to be used on kitchen waste systems.

Note External Rainwater systems are not covered by this specification. For full details of materials and installation requirements for this system refer to the Architectural Specification.

M6-9 GENERAL REQUIREMENTS FOR PIPEWORK SYSTEM

M6-9-1 INTRODUCTION

The general requirements are applicable to all pipework systems and shall be read in conjunction with the detailed requirements as specified later in this section.

M6-9-2 COMPLIANCE WITH LOCAL WATER AUTHORITY

The Contractor shall:

1) Issue all working drawings to the local authority for their comment with regard to water regulations and local requirements (except where Contractor is able to self-certify the scheme with the local authority).
2) Ensure that any certification required is submitted within the time scales specified by the authority in order to ensure that the connection of the water supply is not delayed.
3) Ensure that all systems fully comply with the local water authorities particular requirements.

M6-9-3 PROTECTION

All pipes stored at site prior to installation shall be kept clean, properly racked clear of the ground and covered. Sites selected for storage shall be flat and level and free from sharp stones and flints etc. Pipework storage shall:

1) Utilise off-loading operations that shall only use rope or web slings and provide adequate man or machine power to accommodation this activity. Materials shall not be thrown haphazardly from vehicles by reason of size or lightness or dropped violently.
2) Be stored to prevent dirt and foreign matter entering open ends of pipes. Wood, rag, paper, wood shavings or other inadequate plugs shall not be permitted.
3) Be stored in stacks not exceeding seven layers of pipes or two metres in height, whichever is the lesser.
4) Not exceed a height of ten times the pipe size, up to 75mm diameter, when stacking ABS pipe.
5) Be protected from direct sunlight, properly racked and supported clear of the ground for ABS, PP and all types of PVC pipework and components at all times.

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6) Where any lining or coating has been applied ensure no other pipe or material of any kind shall be placed inside the pipework.

7) When spigot and socket pipes are stacked, ensure the bottom layer of sockets shall be prevented from making direct contact with the ground. Succeeding pipe layers shall have sockets protruding at alternate ends of the stack

8) Shall only allow smaller pipes to be rested inside larger pipes which are adjacent to the ground.

9) Be such that when transporting of pipe lengths subsequent to off-loading the arrangement ensures that neither spigot nor socket ends or flanges become damaged by dragging along surfaces. The pipe supporting surfaces of site vehicles used for handling shall have no sharp projections, and shall provide uniform support to the pipe lengths.

10) Rubber joint rings they shall be stored in their delivery bags and not exposed to sunlight. These shall comply with Building Standard for Elastomeric Seals.

The use of any corroded pipes shall not be allowed. Any corroded or damaged pipework shall be removed and replaced by the Contractor at his expense.

M6-9-4 HANDLING AND CUTTING OF PIPE

All cutting of pipes required shall be:

1) Carried out in a neat and workmanlike manner without damage to the pipe.

2) Carried out in accordance with the manufacturer's recommendations.

3) Made with an approved type mechanical cutter. Wheel cutters shall be used when practicable.

4) Made square to the axis of pipes and all burrs and other irregularities removed by reaming and filing before installing.

Pipes and accessories shall be handled so as to ensure delivery to the installation position in sound, undamaged condition as the following:

1) Pipes shall be carried into position and not dragged.

2) The interiors of pipes and accessories shall be thoroughly cleaned of foreign matter before being placed in position

3) Pipes shall be kept clean during fixing operations by plugging or other approved method.

4) Where required the use of pinch bars and tongs for aligning or turning pipe shall be permitted only on the barrel of the pipe

5) Particular care shall be taken not to injure the pipe lining and coating. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor, at his expense

6) Any Rubber or compound gaskets or sleeves, which are not to be installed immediately, shall be stored in a cool area protected from direct sunlight.

7) Prior to installation, pipes shall be inspected for defects. Material found to be defective shall be replaced with sound material prior to installing.

M6-9-5 INSTALLATION

Pipework shall be installed as recommended by the current BS standard, particular care shall be taken to ensure the following installation is provided:

1) All installations should be installed to the recommendations and guidelines within BS8000.

2) All pipework is erected and secured truly parallel and plumb with vertical surfaces.

3) Where the structure is not able to bare the weight of a pipe or is absent, then secondary steel should be provided.

4) All horizontal branch pipework shall be arranged with a minimum fall from traps as set out in the British Standard or rise in the case of anti-syphon pipework.

5) All connections to drain should be made via a mechanical fitting

6) All bends shall be long radius or two number 45° (degree) bends.

7) All tees shall be long sweep patterns.

8) Long runs of pipework shall be erected so that stresses of expansion and contraction, due to temperature variation, are taken up by expansion joints. Where small bore branches are made to mains remote from anchor points, the branches shall be arranged to form a radius arm so that the axial movement of the main does not stress the connecting fittings.

9) Stub stacks should be installed where appropriate. Where a 740mm dimension cannot be achieved through the lowest branch connection to a stack and offset below [after 3 stories] a stub stack should be introduced. To align with Building Regs, any offsets after a stack travels 5 stories or more should have a stub stack introduced.

10) Offsets from vertical to horizontal should be made up of either 2 x 45 degree bends or a long radius bend. A 45 degree bend combined with a branch connection is not acceptable and contravenes the British Standard.

11) The horizontal pipework should run at least 10 x diameter when offsetting from a vertical run of 3 stories or more.

12) Expansion devices shall be of similar material to the pipe, installed in line with the axis of the pipe and shall be free from compression, tension or torsion. The female member of the expansion devices shall be firmly anchored to allow the male member to take all movement.

13) Jointing rings, couplings and adaptors shall be of types recommended by the manufacturer of the pipes being jointed.

14) Where pipes pass through walls and floors, sleeves shall be fitted to allow free axial movement of the pipes. Sleeves shall be of a material compatible with the pipes they protect, non-combustible and of a minimum bore to allow such movement.

15) Fire collars fixed to the soffit or wall shall be used to prevent the spread of fire where deemed applicable. The annular space between pipe and sleeve shall be packed with intumescent material so as to prevent the passage of fire. Fire wraps cannot all be verified, therefore are not a suitable option.

16) The drainage systems for drainage relief valves should be as designed and installed as out in Building Regs Part G.

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17) Slip-on cover plates shall be provided as a finish to pipework, up to and including 50mm diameter, in occupied areas where pipe work is emerging from a wall. Samples shall be first submitted to the Contract Administrator for approval prior to installation commencing.

18) Condensate from units such as MVHR's. FCU's, etc., should be designed with a tundish and dry trap, connecting to a ventilated stack; if the manufacturer can prove that a 'hard' connection has been tested showing that the negative pressure will not affect the opening of the dry trap valve, then the air break can be omitted.

19) Any concealed pipework shall be installed neatly and as close as possible to the building structure, with due allowance made for supports, brackets, adjacent services and thermal insulation which may be required.

20) Before the operation of condensate from such units as MVHR's, FCU's, etc., which are using a dry trap as part of their drainage setup, the dry trap requires to be primarily flushed with 50-100mm of water, to ensure that the trap device will then function under standard conditions (i.e. 20mm of water).

21) Condensate from boilers, flues & relief valve drainage must not discharge into the rainwater/surface water drainage systems. Roof mounted AHU's should discharge into a bunded gully specifically designed to drain condensate from these units.

22) Union type fittings shall be provided to make up to outlets of basin and sink wastes, drip cups and dilution receivers etc. on pipework up to and including 50mm diameter.

23) Any joints in pipework shall not be made within the thickness of walls, floor or roof, or where they would later be built in.

24) Jointing material shall not project into the bore of pipes, fittings or appliances.

25) Strap-on boss connections are not to be used.

26) Adjustable/Flexi WC connectors shall not be permitted.

27) All connections between soil pipe branches and spigots of ceramic WC fitments shall be made with the appropriate fitting provided by the pipe manufacturer

28) Access plates shall be provided at the foot of each vertical stack and immediately above the point where a stack passes through subsequent floor levels.

29) Access plates shall be provided at all 50mm diameter vertical discharge pipes above FFL within appliance panelling to enable the complete disposal system to be internally cleaned and rodded.

30) Access plates/rodding eyes at FFL level shall not be permitted.

31) Ventilating and anti-syphon pipes above their highest branches shall be continued upwards, at their full diameter, to such a height as to afford a safe outlet for foul air, all as detailed on the relevant drawing.

32) Automatic air admittance valves shall not be permitted.

33) The sprinkler gully, pipework, civil drainage and bunding should be sized so that it is able to cope with the test flow rate from the system.

34) All tank rooms should be bunded with gullies positioned within the bunded area.

35) All roof level penetrations shall be provided with water seal and weather protected installation.

36) Any cast iron stacks balloon vent discharges shall be of copper wire only.

37) All drainage and rainwater pipework that pass through a fire compartment or barrier or floor plate shall be complete with an intumescent fire collar to maintain the fire barrier rating.

38) Any defective pipework installed shall be replaced at the Contractor's cost.

39) The acoustic performance of the pipework should be set out in the project Employer's Requirements and installed to in this manner.

40) A CCTV test should be carried out on the civil scheme prior to handover, to ensure there are no defects, abuse or blockages within the underground drainage system.

Should leaks develop in any system after being set in operation, it shall be the responsibility of the Contractor to repair the leak points and, if damage to the building structure or any item of contents has occurred as a result of such leakage, rectification of the damage shall be carried out by the Contractor at his own expense.

M6-10 MATERIALS

M6-10-1 PIPEWORK SUPPORTS

All pipework shall be supported both vertically and horizontally throughout the entire installation. Pipework shall be supported at centres no greater than those listed below.

PIPEWORK SUPPORTS - MAXIMUM INTERVAL BETWEEN SUPPORTS (IN METRES)																
NOMINAL SIZE (mm)	PVC-U		CAST IRON		ABS		PP		COPPER		HDPE		SS		PVC-C	
H – Horizontal V - Vertical	H	V	H	V	H*	V*	H*	V*	H	V	H*	V*	H*	V*	H*	V*
≤16	-	-	-	-	0.8	1.2	-	-	-	-	-	-	1.5	2.0	-	-
≥17 and ≤23	-	-	-	-	0.9	1.3	-	-	1.8	2.4	-	-	2.0	2.5	0.5	0.5
≥24 and ≤29	-	-	-	-	1.0	1.5	-	-	1.8	2.4	-	-	2.2	3.0	0.5	0.5
≥30 and ≤36	0.5	1.2	1.5	3.0	1.1	1.6	-	-	2.4	3.0	-	-	2.5	3.0	0.5	1.2

≥37 and ≤43	0.5	1.2	1.5	3.0	1.2	1.8	1.2	1.5	2.4	3.0	0.5	1.2	3.0	3.0	0.5	1.2
≥44 and ≤55	0.9	1.2	1.5	3.0	1.3	1.9	1.3	1.5	2.7	3.0	0.8	1.2	3.0	3.0	0.6	1.2
≥56 and ≤68	-	-	1.5	3.0	1.4	2.1	-	-	3.0	3.7	0.8	1.5	3.0	3.0	0.6	1.2
≥69 and ≤81	-	-	1.5	3.0	1.5	2.3	1.5	1.5	3.0	3.7	0.8	1.5	3.0	3.0	0.6	1.2
≥82 and ≤109	0.9	2.0	1.5	3.0	1.6	2.4	1.8	1.5	3.0	3.7	1.0	2.0	3.0	3.0	1.0	2.0
≥110 and ≤ 160	1.0	2.0	1.5	3.0	1.8	2.7	-	-	3.6	4.2	1.5	2.0	3.0	3.0	1.0	2.0

Notes:

*- Refer to manufacturer's specific requirements for additional support locations to suit jointing method.

For sizes not listed refer to manufacturer's 'best practice' recommendations.

M6-10-2 PVC-U PIPEWORK

Where PVC-U pipework is required all pipes and fittings shall be in Unplasticised Polyvinyl Chloride, shall be jointed by solvent welding and comply with the following:

1) Jointing procedure shall be strictly in accordance with the manufacturer's sequence of requirements.
2) Joints between PVC-u and the underground drainage system shall be made using a suitable drain adaptor.
3) Horizontal pipework suspended from the underside of floor slabs shall be supported by means of an approved corrosion resistant suspended bracketing system.
4) Precautions shall be taken to accommodate linear movements within the suspended pipework system. Expansion joints shall be incorporated at approximately 4 metre centres and rigidly anchored.
5) Where changes of direction are at angles less than 45° the bend shall be formed by two close coupled adjustable bends.
6) The branch angle at a junction shall be 45°, an adjustable bend is then cut to the required angle of the side connection.
7) The change of direction from vertical to low gradient pipework is to be achieved by using two 45° bends or a long radius bend and shall be fully supported.
8) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-3 CAST IRON PIPEWORK

Where cast iron pipes are required all cast iron pipework and fittings shall:

1) Be without sockets.
2) Carry BS Kitemark and DN numbering.
3) Be coated both externally and internally in accordance with the following table title 'PIPEWORK COATING'.

PIPEWORK COATING	
LOCATION / ITEM	COATING DESCRIPTION
Pipe externally	Acrylic, anti-corrosion primer coating, red-brown colour, average dry thickness 40 microns
Pipe internally	Two part epoxy coating, ochre colour, with an average thickness of 130 microns
Fittings	Red powder epoxy resin electrostatically applied to an average thickness of 150 microns, externally coated to an average thickness 70 microns
Couplings / brackets	Protected with a red water based semi-gloss paint, average thickness of 40 microns

4) The jointing system to be by two-piece ductile iron couplings incorporating built-in electrical continuity.
5) Stack supports located in accordance with manufacturer's requirements.
6) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-4 ABS SUPERFLO

Where ABS pipework is required all ABS Superflo pipes and fittings shall:

1) Be joined by using ABS solvent cement, no other solvents are to be used.
2) Be jointed strictly in accordance with the manufacturer's sequence of requirements.
3) Where horizontal pipework is suspended from the underside of floor slabs be supported by means of a manufacturers approved corrosion resistant suspended bracketing system and shall be sufficiently rigid to provide lateral restraint to the pipework.
4) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-5 POLYPROPYLENE PIPEWORK

Where chemical resistant and / or polypropylene pipe is required all pipes and fittings to be in polypropylene:

1) All materials and manufacture shall carry BBA certification.
2) Systems within concealed ducts and voids shall be joined by means of electrofusion welding.

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3) Mechanical jointing system shall be installed where system is exposed to view.
4) All component parts of the system shall be covered by a manufacturer's warranty.
5) Precautions shall be taken to accommodate linear movements within the suspended pipework system. Expansion joints shall be incorporated at approximately 4 metre and rigidly anchored.
6) Where changes of direction are at angles less than 45° the bend shall be formed by two close coupled adjustable bends.
7) The branch angle at a junction shall be 45°, and adjustable bend is then cut to the required angle of the side connection.
8) The change of direction from the vertical to low gradient pipework is to be achieved by using two 45° bends or a long radius bend, and shall be fully supported.
9) Bracket spacing and fixings shall be in accordance with the manufacturer's requirements.
10) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-6 COPPER PIPEWORK

Where copper pipework is required all copper pipework, up to and including 76mm, shall:

1) Be half hard R250 copper tube and fittings.
2) Where bends and sets in R250 piping, up to and including 54mm diameter, are required these may be made on site where standard fittings cannot be used or where this method will give a neater appearance.
3) Not permit pulled bends or offsets which show flattening, rippling or constriction of the bore.
4) Be of copper or copper alloy specifically designed to carry the flow of non-corrosive wastewater under conditions of gravity head.
5) Use capillary type joints having either an integral solder ring or facility for introducing solder by means of heat.
6) Where fittings incorporating screwed threads to shall be jointed using jointing compounds complying together with PTFE tape.
7) Be jointed between copper tubes and capillary type fittings made in accordance with the manufacturer's recommendations.
8) Be jointed between copper pipes and cast iron made by the use of a suitable copper alloy connector with integral capillary fitting to receive the copper pipe.
9) In rooms be supported by means of single or double ring brass clips with malleable iron back plates plugged and screwed to the walls or floor.
10) Within ducts and voids be supported by means of single or double ring brass clips with malleable iron back plates either rigidly bolted to mild steel channel bearers or plugged and screwed direct to the structure.
11) Have horizontal pipes suspended by purpose-made pipe hangers comprising mild steel drop rod, the top end threaded and fixed to the structural slab by means of a proprietary fixing, the opposite end threaded to receive a brass single pipe ring.

    Alternatively, the drop rod shall pass through a hole drilled through the soffit and secured by means of a 150mm x 150mm x 6mm back plate and nut. The nut being tack welded to the rod after final adjustments have been made.
12) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-7 STAINLESS STEEL PIPEWORK

Where stainless steel pipework is required all stainless steel pipework shall:

1) Be a completely stainless steel system including all pipes and fittings.
2) Carry a BBA certificate.
3) Where changes of direction are at angles less than 45° the bend shall be formed by two close coupled adjustable bends. The branch angle at a junction shall be 45°.
4) Change direction from vertical to low gradient pipework using two 45° bends or a long radius bend, which shall be fully supported.
5) Only be undertaken using manufacturer's approved tools.
6) Be installed with bracket spacings and fixings fully in accordance with the manufacturer's requirements.
7) Ensure all component parts of the system shall be covered by a manufacturer's warranty.
8) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-10-8 PVC-C PIPEWORK

Where PVC-C pipework is required all PVC-C pipework shall:

1) Be jointed fully in accordance with manufacturer's jointing instructions.
2) Only be jointed using manufacturer's recommended solvent cement.
3) Be supported by means of manufacturers approved corrosion resistant bracketing systems.
4) Be provided with required supports and spacing to account for expansion and contraction.
5) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.
6) Be pressure rated dependant on diameter as tabulated below:

PRESSURE RATING

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SIZE	RATING
15mm diameter up to and including 160mm diameter	PN 16
Greater than 160mm diameter	PN10

M6-10-9 HDPE PIPEWORK

Where HDPE pipework is required all HDPE pipework shall:

1) Be jointed by electrofusion couplings throughout. The jointing procedure shall be strictly in accordance with manufacturer's sequence of requirements and using the manufacturer's approved electrofusion machine.
2) Pipework shall be installed to minimise stress on system and shall incorporate:
   a) As a minimum requirement an expansion fitting at each floor.
   b) Each expansion fitting shall be installed with anchor bracket around coupling.
3) Guide brackets location from the anchor bracket shall generally be located:
   a) Vertical stacks = 15 times the pipe diameter
   b) Horizontal pipe = 10 times the pipe diameter.
4) All expansion joints and guide brackets in accordance with the manufacturer's requirements.
5) Drop rod distances and diameters must be in accordance with manufacturer's requirements.
6) Bracket spacing shall be in accordance with the previously listed pipe support section or to conform to manufacturer's requirements, whichever is the most onerous.

M6-11 ACCESSORIES

M6-11-1 TRAPS

General

Traps to lavatory basins, sinks and urinals shall be 75mm seal, re-sealing bottle with detachable base made from Polypropylene.

Ceramic soil appliances shall have 50mm deep seal integral traps.

Anti-syphonic traps

Anti-syphonic traps shall be installed where syphonic conditions may develop and as detailed on the drawings. These traps shall be complete with automatic air release valve to neutralise pressure and prevent any effect on the water seal within the trap.

Fan Coil Unit Condensate Traps

Drainage from fan coil condensate system shall discharge via a tundish. Pipework from tundish shall run to fall and be complete with an inline "Dry trap" installed within vertical pipework before discharging into the drainage stack. Dry trap complete with soft silicone rubber membrane to provide seal.

Air Handling Coils and Recuperators

Drainage from Air handling unit shall be via a Glass trap and tundish dish direct to drain.

M6-12 TESTING

All pipe work systems shall be subject to the inspection and testing procedures specified herein.

No covering or enclosing of pipework whatsoever shall be applied until such inspection and testing is satisfactorily concluded.

M6-12-1 GENERAL

All above ground drainage and vent pipes within buildings shall be tested as specified and to the satisfaction of the Supervising Officer/Local Authority Representative.

Testing shall be carried out after main stacks have been fixed in position and all branch piping installed (but before the piping has been concealed and equipment fixtures and fittings have been set and connected).

The test for soundness shall be by air.

The Contractor shall provide clean water and all assistance and apparatus for the tests to be carried out.

It is the responsibility of the Contractor to notify the Supervising Officer and others concerned when the installation is ready for testing.

The Contractor shall ensure that each section of the above ground drainage system is completely clear of any obstruction, debris or superfluous matter before any tests are applied to a section and upon completion of the contract.

Upon completion of the contract, the entire installation shall be thoroughly flushed with clean water to prove the efficiency of the system in the presence of the Supervising Officer.

All testing shall be carried out in the presence of the Supervising Officer/Local Authority Representative and a signed certificate obtained as proof of witness. This in no way absolves the Contractor of his obligations under the Contract.

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M6-12-2 PROCEDURES FOR TESTING

The procedures for air testing shall be as follows:

1) Prior to testing, all access covers and cleaning eyes shall be removed and greased where appropriate, replaced and sealed.
2) Prior to testing, the section of the installation to be tested shall be sealed off by the insertion of expanding rubber or inflatable canvas stoppers into ends of all pipework to be included in the test.
3) Where possible, these stoppers shall be further sealed with water sufficient only to cover the internal face of the stopper.
4) The stopper at the top of the section of pipework to be tested shall be fitted with a 'tee' fitting complete with an efficient and serviceable air cock on each of the two free ends of the fitting.
5) One of the air cocks shall be connected by means of a flexible tube to a manometer. The other air cock shall be connected to a tube for applying the air pressure to the system.
6) Air pressure shall then be applied to the whole section of pipework and fittings under test. This shall be equal to 50mm water gauge and shall be held constant for a period of five minutes. No additional pressure shall be applied during this time.
7) The tests will be deemed to be satisfactory if the 50mm water gauge pressure is held.
8) Leaks shall be detected by the application of soap solution to the joints whilst the system on test is under pressure, the presence of bubbles indicating the affected joint.

M6-12-3 TEST CERTIFICATE

An interim test certificate form shall be completed by the Contractor and presented for signing by the Supervising Officer as witness to the successful testing of each section of the work as the Contract proceeds.

A final test certificate form shall be completed by the Contractor and presented for signing by the Supervising Officer as witness to the successful testing of the system in its entirety immediately prior to the completion of the Contract and commencement of the maintenance period.

Test certificates shall show date of test, description of pipeline, or section of pipeline undergoing test, pressure applied, duration test pressure was maintained, number of leaks observed, leakage rate observed, persons present.

M6-13 KITCHEN WASTE SYSTEMS

A robust easy cleanable, metal waste system suitable to receive constant high temperature discharges shall be installed. The system shall provide the following features:

1) Sink traps shall be two piece tubular with 75mm water seal and sump drain plug.
2) No flat gradient will be accepted.
3) Branch discharges from macerators shall be as short as possible and connect directly to main discharge pipe or stack.
4) Wastes from Pot wash sinks, Pre-rinse sinks and Combi-ovens shall be piped through grease removal machines to comply with Building Regulations Part H,
5) Grease removal machine outlets must be provided with a vent pipe to prevent siphonage of the machine.
6) Grease Removal Machines shall be capable of automatically skimming off the grease into a container in readiness for removal and re-cycling.

M6-14 WASTE DISPOSAL UNITS

Where waste disposal units are provided the discharge from these shall be installed directly to the vertical waste stack, no other fitment shall connect to this. The waste disposal unit shall be positioned to achieve the shortest distance to the stack, without bends and be provided with gradient all installed to the manufacturers requirements.

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M6-15 APPENDIX

M6-15-1 PIPEWORK SYSTEM MANUFACTURERS

SYSTEM	MANUFACTURER	
PVC-U PIPEWORK AND FITTINGS	Polypipe Terrain Limited ME20 7PJ [redacted]	Wavin Ltd SN15 5PN
C-PVC PIPEWORK	Durapipe UK WS11 9NS Tel No. 01543 279909	
HDPE PIPEWORK	Polypipe Terrain Limited ME20 7PJ [redacted]	Geberit Sales Ltd. Geberit House, Edgehill Drive, GB-CV34 6NH Warwick
CAST IRON PIPEWORK AND FITTINGS	Saint-Gobain Pipelines PLC DE7 4QH [redacted]	
ABS PIPEWORK SUPERFLO	Durapipe UK WS11 9NS [redacted]	
STAINLESS STEEL PIPEWORK AND FITTINGS	ACO Building Drainage ACO Business Centre, Caxton Road, Bedford, Bedfordshire, MK41 0LF	Blucher UK LS24 9SG [redacted]
STAINLESS STEEL GULLIES & CHANNELS **(in kitchens, plaster rooms and channels in wet change areas)**	Component Developments TF7 4QP [redacted]	ACO Building Drainage ACO Business Centre, Caxton Road, Bedford, Bedfordshire, MK41 0LF
SEDIMENT TRAPS	Component Developments TF7 4QP [redacted]	
GREASE REMOVAL MACHINES	Clearflow Enviro Tech Ltd 6 Lakeland Business Est, Faverdale Ind Est Darlington England DL3 0PX	ACO Building Drainage ACO Business Centre, Caxton Road, Bedford, Bedfordshire, MK41 0LF
FIRE SLEEVES FOR PVC-U	Dufaylite Developments Limited [redacted]	
PLANTROOM GULLIES	Wade International Limited [redacted]	
WASTEWATER PUMPS	Flow Mech CT4 6DQ [redacted]	
ALUMINIUM PIPEWORK AND FITTINGS	Guttermaster OL12 6ND [redacted]	Alumasc Burton Latimer Kettering NN15 5JP
RAINWATER OUTLETS (INTERNAL)	ACO Building Drainage ACO Business Centre, Caxton Road, Bedford, Bedfordshire, MK41 0LF	Alumasc Burton Latimer Kettering NN15 5JP

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Section M7

Building Management System

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M7-1 GENERAL REQUIREMENTS

This section of the specification details the design, supply, installation, testing, commissioning and setting to work of the complete building management control system, including control panels, wiring, containment and sensors, for the project.

This work is specified on a performance basis with design development from the performance requirements listed in this controls section being developed to provide a completed design that is fully installed and commissioned by the Controls Specialist. The Building Management System shall control all mechanical and electrical equipment detailed within these tender documents.

M7-2 DEFINITIONS

Refer to Section 1B for general definitions plus:

DEFINITIONS	
Automatic control system	Building energy management system and/or automatic control system
BMS	Refers to the building management system and/or automatic control system as a whole.
Control Panel	Control panel, outstation, motor control centre associated with the system being described
Controls Specialist	Controls specialist employed to complete the automatic controls installation as described in these tender documents including all descriptions in other sections of this specification
ELV	Extra Low Voltage
LSOH / LSZH	Low Smoke Zero Halogen (and Fume)
MCC	Motor Control Centre
Outstation	Programmable controller usually housed in an MCC or integrated into an item of plant
PC	Personal Computer
VFC	Volt Free Contacts

M7-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the installations.

The following text advises if the Contractor shall deviate from the preferred materials and standards or utilise one of the alternative materials and standards of construction listed in the 'General Installation Standards' sections detailed earlier in this specification. Agreed alternative materials for the installation from the preferred standard material and standard of construction are:

No deviation from the 'General Installation Standards sections 2A to 2F inclusive'.

WIRING AND CONTAINMENT OF THIS ENTIRE BUILDING MANAGEMENT SYSTEM

The wiring and containment installation shall be carried out, by the Controls Specialist, fully in accordance with Section Standards 2E (Electrical Workmanship and Materials) and 2F (Electrical Inspection and Testing) of this specification.

This is required to ensure that the projects entire installation is carried out to the same standard throughout (specifically the installations by the Electrical Contractor and the BMS Electrical Contractor are to identical standards).

M7-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

STANDARDS	
BS 5472 Specification for low voltage switchgear and control gear for industrial use	BS HD 60269-2, BS 88-2 Low voltage fuses
BS EN 12098 Controls for heating systems	BS EN ISO 16484 Building automation and controls systems (BACS)
BS EN 13601 Copper and copper alloys. Copper rod, bar and wire for electrical purposes	BSRIA AG 7/98 Library of System Control Strategies
BS EN 15232 Energy performance of buildings	BSRIA AG 9/2001 Standard Specifications for BMS
BS EN 60038 CENELEC standard voltages	BSRIA AG 10/2001 – The effective BMS
BS EN 60051 Direct acting indicating analogue electrical measuring instruments and their accessories	BSRIA BG4/2003 BMS Maintenance Guide

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STANDARDS	
BS EN 60073 Basis and safety principles for man-machine interface, marking and identification	Building Controls Industry Association (BCIA) Guidelines
BS EN 60529 Degree of protection provided by enclosures (IP code)	CIBSE Commissioning Code C: Automatic controls
BS EN 60947 Low-voltage switchgear and control gear	CIBSE Guide H: Building control systems
BS EN 61439 Low-voltage switchgear and control gear assemblies	International Electrotechnical Commission (IEC) Standards
BS EN 61869 Instrument transformers	PD CEN/TR 12098 Controls for heating systems
BS EN 62477 Safety requirements for power electronic converter systems and equipment	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M7-5 SCOPE OF WORKS

The Contractor shall be responsible for the full design, supply, installation, testing and commissioning of the automatic controls systems and motor control panels.

All this equipment shall be supplied and installed by a Controls Specialist who shall provide power and automatic controls to the following:

1) Air handling units, heat recovery units and ventilation systems.
2) Dirty extract ventilation systems.
3) LTHW heating systems fed from air to water air source heat pumps.
4) Domestic Hot and Cold Water Installation.
5) DX and VRV cooling installation.
6) Renewable energy systems specifically photovoltaic array.
7) Entire electrical installation for both power and control wiring that is required to be installed from the new control panels for a complete installation. Only electrical power supplies listed specifically as being provided by others shall be provided by others.
8) BMS installation shall be installed within its own segregated distribution containment throughout the installation.
9) All power and controls wiring in ALL occupied areas shall be totally concealed with no surface containment being acceptable.
10) All motors shall be provided with separate stand-alone variable motor speed inverters.
11) Commission all power and controls systems.
12) Liaison with other trades on site, including attending meetings.
13) Operation and maintenance instruction and documentation.
14) Preparation of builder's work drawings and details.
15) Preparation of specified documentation during installation, commissioning works, Operating and Maintenance and log book information.
16) Include for all graphics and software for the new system.
17) Allow for full testing and commissioning of systems.
18) All post commissioning activities.
19) All necessary additional detectors not shown on the concept drawings or points schedule, but required to carry out the control modes shall be included by the Controls Specialist.
30) Provide a 'Design Warranty' if requested by the client (ensure this is included for at tender).

M7-6 MANUFACTURERS AND SUPPLIERS

The complete building management system shall be provided by:

CONTROLS SPECIALISTS
Only controls companies who are **Trend Technology Centres** or **Trend System Integrators** shall tender for and carry out works. No system other than Trend shall be used for building services control systems.
SOFTWARE & PROTOCOLS SYSTEM
IQView4. Controllers shall always be of the Trend IQ4 family of controllers. All I/O modules shall be Trend and the use of multiplexing devices on either inputs or outputs is expressly forbidden.

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CONTROLS SPECIALISTS
Where interfacing with third party equipment, such as CHP is required, this shall be via BACNet or Modbus where possible. Where this is not possible the objective will be to gather as much information from the unit as practically possible to facilitate remote diagnosis of the unit's condition and performance. Controls proposals in the form of description of operations and drawings shall be provided to the client before the control panel is constructed and brought to site. The BMS shall be a fully addressable IP based system using the latest components, outstations available at the time of Tender. Protocol shall be a full "Native" BACnet wherever available using BACnet/IP. Communications shall be across the network shall be ISO 8802-3 "Ethernet". Where a "Native" device is not available a proprietary system shall be offered with hardware (gateways etc.) to allow the device to communicate via BACnet, all such devices shall be scheduled and issued for comment prior to final selection. Alternative protocol devices shall only be included where there is no technically compatible product available (i.e. cost is not considered a valid reason for providing an alternative device).
The automatic control system shall be the latest compatible technology available from the manufacturer. Equipment due to be superseded /deleted from the manufacturers range in the next 12 months, post proposed completion date, shall not be employed. This shall be verified with the manufacturer in writing prior to the equipment being ordered.

M7-6-1 SPARE SYSTEM CAPACITY

The Controls Specialist shall allow for providing and installing a system that has a minimum of 20% spare outstation capacity. This spare outstation capacity shall be backed up by the equivalent amount of spare memory within the central processing unit.

It is required that any additions to the BMS during installation stage shall not reduce this 20% spare capacity and that the system shall be handed over with this level of capacity for future site development.

Note – 20% spare capacity is to be provided to all DI, DO, AI and AO devices and space for additional power circuitry.

M7-6-2 INTERNAL AND EXTERNALLY LOCATED EQUIPMENT, SENSORS AND CONTAINMENT

The entire building management controls system covered by this section of the specification shall be fully suitable for the location that it is being installed.

For clarity, in terms of ingress protection (IP) rating, the following shall apply throughout the whole project:

LOCATIONS	DESCRIPTION / REQUIREMENT
Externally and any other locations not classified as waterproof and weathertight.	Entire installation located in these locations shall be certified as IP65 rated or better. Secondary enclosures to improve the insufficient IP rating of equipment shall not be acceptable unless it is proven that sufficient IP rated equipment is not available and the equipment could not be located in a more suitable location. For example, valve bags to provide necessary weather proofing are not acceptable as suitable IP65 rated valve actuators are available. For example, not all motor inverters are available with IP65 rating but there are sufficient quantities available not to require the installation of an insufficiently rated product. It is preferable for equipment and components to be located internally if practical inside dedicated valve or inverter enclosures built into the AHU themselves if possible. Note – locating inverters inside AHU fan sections is not permitted as the inverter cannot be maintained or adjusted due to the proximity of moving fan components. Under no circumstances shall any product that is labelled as for 'internal use' be installed externally.
Internal locations that are classified as watertight and weatherproof whether heated or unheated.	Entire installation located in these locations shall be certified as IP31 rated or better.

M7-7 BMS POWER SUPPLIES

POWER SUPPLIES BY CONTROLS SPECIALIST
All power supplies associated with the Building Management System serving mechanical services equipment shall be designed, supplied, installed and tested by the control specialist, this includes provision of power supplies to all sundry items, such as condensation heaters, trace heating systems etc. The ONLY exception is those supplies specifically stated as being installed by the site electrician which are listed below. All wiring shall be completed fully in accordance with the manufacturer's instructions, current British Standards and as detailed in this specification.
POWER SUPPLIES AND INTERFACES BY ELECTRICIAN
The Electrical Contractor shall provide a single electrical power supply to each of the following: **Each motor control panel in each mechanical services plant room to serve the equipment located in the plant rooms and associated adjacent external mechanical equipment.**

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As stated above, all other power and controls wiring shall be provided as part of the Building Management System work, with the exception of the following local power supplies which shall be provided by the Electrical Contractor:

1) Air to Water Air Source Heat Pumps.
2) Direct expansion refrigeration systems including DX and VRV systems.
3) Local drinking water boilers.
4) All local stand-alone extract fans including en-suite ventilation fans.
5) Small stand-alone local extract fans.

All controls required to the above, irrespective of who provides the power supplies, shall be provided as part of the Building Management System.

The Control Specialist shall ensure that panel isolators, terminal etc. are suitable sized to accept the incoming supply, also review electrical loadings early in the project and advise if there is any discrepancy between to specified supply and the peak loading of the control panel.

A single feed shall be provided to each control panel, so all interconnections between panel sections shall be carried out by the Control Specialist.

The Controls Specialist shall supply complete wiring diagrams of the installation with all interconnecting wiring shown, along with terminal strip details and cable numbers.

The drawings shall clearly define the areas of work so that the following may be achieved.

M7-8 INTERLOCK TO BUILDING FIRE ALARM SYSTEM

FIRE ALARM INTERLOCKS SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Interlocks	All control panels and motor control centres	All control panels shall be linked to the fire alarm system via a test key switch to allow fire alarm testing without interrupting the normal operation of the BMS. Fire alarm interlocks to disable all services after any safety run on features for pumps only have run for required time period. All ventilation fans shall be immediately disabled. Fire alarm interlocks shall be provided within 5 metres of the panels and centres by others for final termination into the panels by BMS specialist. All emergency interlocks shall be hard wired.

M7-9 ALL CONTROL AND INTERFACE WIRING AND CABLES

CONTROL WIRING AND CABLING THROUGHOUT THE PROJECT

All controls wiring and cables associated with the Building Management System serving mechanical services equipment shall be designed, supplied, installed and tested by the control specialist.

All wiring shall be completed fully in accordance with the manufacturer's instructions, current British Standards and as detailed in this specification.

All wiring of communications links between the new outstations, unitary controllers and interconnecting of the outstations into the site BMS data communications ring shall be by the Controls Specialist.

All wiring and wire numbering internal to the control panels up to the terminal strips shall be carried out by the control panel manufacturer.

All wire numbering into and out of the motor control section panel terminal strips to the associated plant shall be carried out by the Controls Specialist.

M7-9-1 FIXING OF EQUIPMENT

The following philosophy shall be adopted on site for fixing of control items:

1) Pipework mounted valves shall be provided and fixed by the Mechanical Contractor. Actuators shall then be positioned and wired on these valve bodies by the Controls Specialist.
2) Wall mounted temperature and humidity detectors and the like shall be supplied, fixed and wired by the Controls Specialist.
3) Ductwork or pipework mounted control items, such as sensors, switches and devices shall be given as free issue items, by the Controls Specialist, to the Mechanical Contractor for his site erectors to fix. The Controls Specialist shall then wire these.
4) The Controls Specialist shall allow for providing immersion sensor pockets for all pipe mounted temperature detectors such that detectors can be removed without the need for draining of the system. These pockets shall be packed with a heat conducting compound.

M7-9-2 DESIGN AND LABELLING OF USER CONTROLS

All local controllers provided for end user adjustment shall be clearly and concisely labelled, all labelling shall be in non-technical English that is easy to understand for non-technical / non-engineering users.

All local user controls shall be designed in accordance with the principles detailed in Building Controls Industry Association (BCIA) 'Controls for End Users'.

All controllers shall be suitable both aesthetically and in scale for their intended locations. Materials and finishes shall be agreed with the Project Architect and Engineer.

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M7-9-3 MOTOR INVERTERS

Stand-alone variable speed motor drives shall be provided to all motors and these shall comply with the relevant industry standards including those listed in 'Standards Applicable'.

Drives shall carry CE certification where available and fully comply with associated directives on electromagnetic compatibility.

The inverter drives shall be manufactured by:

- Schneider Electric,
- ABB
- Danfoss,
- As agreed with the Engineer.

The smoothing capacitors shall be selected in conjunction with the level of harmonics generated to give a 20 year life under normal operating conditions.

Power factor for the fundamental frequency shall be better than 0.98, and vector power sum power factor trunking taking into account harmonics shall be better than 0.9.

Under no circumstances shall the (voltage) total harmonic distortion on the main supply exceed 2.5%, based on a 400kVA nominally rated supply, located within 50 metres of the panel. This shall be proved by calculation and subsequently demonstrated by site measurement by the Controls Specialist.

Inverters shall be located adjacent to the motor that they are associated with and shall be fully protected from external weather and also adequately ventilated fully in accordance with the inverter manufacturers recommendations.

M7-9-4 LOCAL ISOLATION FOR ALL MOTORS

Adjacent to each motor there shall be a local isolator shall be provided to isolate the associated motor drive and its speed controller inverter.

Whenever such a stop-lock button is in its depressed position it must not then be possible for power to be applied to the motor, either momentarily or otherwise.

Where stop buttons are located in thoroughfares protective metal guides shall be provided to prevent accidental operation. The design of the guards shall be such to allow unrestricted access in the case of emergency.

M7-9-5 DETECTORS AND SENSORS

All detectors and sensors etc. required to fulfil the design intent shall be included by the Controls Specialist.

ROOM MOUNTED DETECTORS AND SENSORS	
SENSOR	DESCRIPTION / REQUIREMENT
Room Temperature Measurement (TX)	The sensors shall complete with type III +/- 0.2°C, 0-40°C (non-condensing) thermistor elements and shall be provided to measure the room space temperature. The thermistor shall not deviate from the accuracy specification for a minimum of 5 years. Install wall mounted units at 1500mm above finished floor level within the room served. Shall be confirmed as accurate when installed and operational, any drift in accuracy corrected within the software routines.

M7-9-6 SELECTION AND SIZING OF CONTROL VALVES

When selecting control valves:

1) All motorised valves shall be of the 3-port or 2-port type as indicated on the drawings.
2) All valves shall be fully modulating, unless noted otherwise, and sized for the flow rates given on the schematic drawings, specification or determined by the designer.
3) All motorised control valves shall be of the rotary shoe or lift and lay type.
4) All control valves shall be installed with eccentric reducers to promote air venting and prevent air locking where the pipe sizes reduce in size.
5) All control valves are to have stainless steel seats.
6) Zone control valves provided for zonal time control where on/off operation is required the valve shall be line size to present the minimum resistance possible.
7) All valves shall be complete with actuators and necessary linkage kits.
8) Allow for all reductions in pipework sizes immediately adjacent to the valve as necessary. All isolating valves shall be installed as full pipe size and NOT control valve size.
9) Obtain the exact flow rates for final valve selections.

CONTROL VALVES				
VALVE	USE	PRESSURE DROP	TYPE	VALVE AUTHORITY
2-Port control valves	Proportional control	20 to 25kPa or to suit manufacturer's range if		0.5

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CONTROL VALVES				
VALVE	USE	PRESSURE DROP	TYPE	VALVE AUTHORITY
		pressure independent control valve.		
2-Port zone valves	Proportional control / 2 position	Line size – not to exceed 5kPa		Not applicable
3-Port blending valves	Mixing applications for variable temperature / compensating circuits	Equal to pressure loss through the variable flow portion of circuit	Mixing valve in diverting application only	0.5 to 1.0
3-Port valve at coils	Proportional control	Equal to loss through coil	Mixing valve in diverting application only	0.5 to 1.0

M7-9-7 PRESSURE, FLOW AND VELOCITY SWITCHES AND SENSORS

All switches and sensors shall be selected to operate accurately at the design pressures, flows and velocities that they are required to operate.

Where duct and air handling unit mounted sensors are required proprietary duct probes shall be used for all sensing points.

All pipe detectors shall be complete with a separate pocket for each sensor.

M7-9-8 OTHER PERIPHERAL AND SENSORS

The Schematic drawings are representative only of the control loops and detector positions required. Not all sensors, switches and detectors are shown on the tender drawings.

Where the particular functions are carried out differently to that shown on the tender drawings include all additional detectors, sensors and relays required for a fully functional system within the tender costs.

M7-10 TIME PROGRAMME AND DATE PROGRAMME

Time programmes shall be in five minute steps, date, season and weekly. Programmes shall be able to call further programmes, issue commands, initiate protocol, dump historical data onto an external storage medium, call formula files and set remote set points (hard/soft).

All main items of equipment, systems and zones shall have a discrete time schedule and demand sequencing facilities. A seven day time schedule facility shall be provided for the same. Thus allowing the user the greatest level of flexibility. Access to the time programme facilities for each system shall be easily accessible using the front end user interface unit via the graphics package.

A global time schedule shall be provided for both complete installations, local zones and the whole project – the final actual requirements shall be discussed and agreed with the client during the regular technical meetings and shall be detailed in the description of operation that shall be provided by the Controls Specialist.

M7-11 GRAPHICS CAPABILITY

Graphics and controls proposals in the form of description of operations and drawings shall be provided before the control panel is constructed and brought to site.

A graphic interface facility shall be provided using industry standard symbols, supplemented by manufacturer's proprietary symbols system where a symbol is not established. The graphics shall be simple to construct such that the user can modify and amend with minimal training to achieve this.

Provide a colour graphic for each and every system displaying all set points, functions, time zones, alarms etc. These shall be provided early in the project for review with users prior to installation.

All graphics shall be produced and tested prior to the soak period, control specialist shall present the graphics to the client in sufficient time to allow review and incorporation of any comments such that a fully operational graphics system is operating throughout the soak test period.

M7-12 SPECIAL TOOLS AND LICENCES

Any special tools, licences, operating handles or other equipment necessary for installation, maintenance or operation of the equipment, shall be provided in suitable quantities.

M7-13 COLLATERAL WARRANTY

During the tender period determine if a collateral warranty also referred to as a 'Design Warranty' is required to be provided for the overall design and if required then this shall be included for within the tender return. It shall not be acceptable exclude this if it is required as part of the Main Contract preliminaries.

M7-14 SITE SUPERVISION & MEETINGS

Include for necessary number of site visits to be attended by the Controls Specialist to:

1) Coordinate all controls, power and controls containment and all wiring between all parties, which shall be needed during the course of construction.
2) Agree all system description of operations with the Client and Engineer.
3) Attendance of all commissioning meetings.

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4) Post contract completion, the Controls Specialist shall liaise with the Commissioning Manager to ascertain programme for meetings. For tender allow for attending fortnightly commissioning meetings, each lasting ½ day.

These regular technical BMS Meetings during the construction phase to agree all necessary documentation procedures and documentation compilations shall be included for. These meetings shall be held during the early building construction phase, well in advance of the BMS installation commencing on site and attended by both Contract and Controls Specialist.

M7-15 INSTALLATION DOCUMENTATION

In addition to the information required detailed elsewhere of this specification the following shall be provided:

1) Panel sizes, weights and noise levels.
2) Detailed panel fascia layouts of all control panels, user interface panels etc. drawn to scale and indicating all components, finishes, locking arrangements etc.
3) All controls and instrumentation drawings and software logic compilation drawings shall be provided during the construction period for comment prior to any work being undertaken on site.
4) Detailed description of controls operation to demonstrate full understanding of the performance specification and show how system will achieve these criteria.
5) Schedule recording as commissioned settings for all programmable components such as inverters etc.
6) Appended to the above shall be any suggestions / comments on how system performance could be improved / energy consumption reduced.
7) Manufacturers data on control items, sensors etc.
8) Verify all working drawings to ensure that automatic control system items are indicated and correctly located for optimum performance.
9) Include all tag referencing and point to point wiring diagrams.
10) Final full documentation shall be provided in accordance with the Contract Preliminaries requirement and as a minimum all documentation shall be provided 14 days prior to handover.

M7-16 TESTING AND COMMISSIONING OF AUTOMATIC CONTROL SYSTEM

The Control specialist shall test and commission the automatic control system fully in accordance with recommendations of all industry standards including 'Standards Applicable' and to prove that 100% of the installation has been proven to be operating correctly and in accordance with the overall services design.

The Controls Specialist must take account of the proposed programme of works and allow sufficient costs and resources for the full commissioning and demonstration of the system to the design intent (both on-site and off-site).

The commissioning process shall be fully and comprehensively tested and proven with each individual system proven for correct operation, this testing and proving exercise shall be fully documented by the Controls Specialist and these documents shall be provided to the Contract Administrator.

All safety related interlocks and controls procedures shall, initially be tested by the Controls Specialist and then be fully witnessed and signed off by persons nominated by the Contract Administrator (e.g. commissioning manager if one is employed) to ensure all safety requirements are 100% proven and witnessed.

The Controls Specialist shall allow for pre-commissioning the MCC's at the panel manufacturers premises prior to delivery to site and this shall include for the following:

- Wiring validation checks.
- Software loading.
- Software programming proving checks.
- Software and hardware communication checks.

This pre-commissioning shall be witnessed by persons nominated by the Contract Administrator (or Commissioning Manager, if employed on project). The Mechanical Contractor shall ensure all necessary information to include for this visit is scheduled within the overall programme.

Fully detailed test sheets for the point to point testing shall be provided by the Controls Specialist to the persons nominated by the Contract Administrator (or commissioning manager if one is employed) for the project who shall undertake 100% verification of point to point, cause and effect, safety system / interlock checks etc.

In addition to the above provide attendance / liaison as set out in the main commissioning section of this specification.

The entire controls installation shall be proven to operate correctly should a total power failure occur (black start) and also prove all delayed start equipment operates as intended.

M7-17 SOAK TEST PERIOD

As detailed elsewhere in this specification a soak test period shall be completed prior to practical completion.

During the soak test period the BMS shall be fully operational without fault along with all graphics etc.

During the soak test period the BMS shall:

1) Be operating under full automatic control with no overrides, interventions, etc.
2) Be fully commissioned.
3) Record all alarms.
4) Log all critical conditions i.e.:
   a) Room temperatures.
   b) Plant operating speed.

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c) LTHW / DHW water operating conditions.

d) Ambient conditions.

All logs shall be recorded and exported to Excel spread sheets for further analysis.

The control specialist shall produce a report at the end of the soak test period complete with schedules of any faults / out of range values recorded during the test period and graphs of key areas.

The format of the report and schedule of points to be logged shall be agreed with the Contract Administrator prior to the soak test period commencing.

The systems (including the automatic controls and associated plant) are required to operate without fault during the whole of the soak test period.

M7-18 ADDITIONAL INFORMATION FOR O&M MANUAL / LOG BOOK

The following information shall be provided both in paper copy for each manual and electronic format:

1) A complete description of the operation and control strategies of the services in the building for inclusion in the O&M manual.

2) Schedule of all set points and final values entered during programming and commissioning of the systems.

3) A simple description of the operation and control strategies of all energy consuming services in the building for inclusion in the building log book. These descriptions shall be in concise, plain and simple English intended for use by non-technical personnel.

4) All drawings updated to reflect actual installation and any alterations made during commissioning of the systems.

5) Backup copy of all programs, software routines, graphics etc. to provide a complete copy of the system "as commissioned". The backup shall be provided on a separate CD, a copy of which shall be included in each manual.

M7-19 PERFORMANCE DESCRIPTIONS

M7-19-1 GENERAL REQUIREMENTS

The building management system shall monitor and control the equipment listed in these tender documents. All requirements are detailed on a performance basis for design development by the Controls Specialist.

Not all sensors / controllers are individually detailed in the Tender documents but the Contractor's design shall include all those necessary for a fully functional and complete installation.

Where set points are given these are not an exhaustive list and are initial values only, these shall need to be reviewed and adjusted during commissioning and subsequent fine tuning so all set points shall be easily adjustable via user graphics.

The automatic control system shall not rely on data communication over IT.

M7-19-2 ALARMS

The status of all alarms shall report to the head end / display on control panel as appropriate. Sufficient start up delays and timers shall be introduced to ensure that false alarms are not initiated during normal operation of the system. Alarms shall be graded as follows:

EXAMPLES OF ALARM LEVELS			
CONDITION	WARNING	STANDARD	CRITICAL
Out of range value or condition	✓		
Excessive energy consumption (out of range over an agreed time period)	✓		
Storage tanks over temperature	✓		
Filter dirty		✓	
Duty pump failed and operating on standby device		✓	
Low flow condition		✓	
Trace heating failed during summer mode		✓	
Low level in water tank			✓
System failed			✓
Both run and standby pumps failed			✓
Failure of life safety system			✓
Trace heating failed during winter mode			✓
Lift fault condition			✓
Pressurisation unit fault			✓

The alarm handling system shall ensure that critical alarms are not lost in amongst a series of warning and standard alarms that do not need immediate attention.

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M7-19-3 GENERAL SYSTEMS AND EQUIPMENT CONTROL REQUIREMENTS

The following are descriptions of control and monitoring of systems and equipment to be controlled by the BMS for the whole installation. These minimum requirements shall be monitored and controlled by the controls system.

Each items of equipment/system shall be complete with a hand/auto/off selector switch such that when running in auto it is under the full control of the building management (DDC) system. When in the hand position the system shall override the time schedule facility and operate the equipment accordingly.

M7-19-4 AIR TO WATER AIR SOURCE HEAT PUMP SYSTEM DESCRIPTION

AIR TO WATER AIR SOURCE HEAT PUMP SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Air to Water Air Source Heat Pumps.		The Air to water air source heat pumps, primary buffer vessel and plate heat exchanger shall be provided by the ASHP manufacturer. The following controls are indicative only and require discussion between the BMS engineer and the ASHP specialist to determine the correct operation of both the primary and secondary side heating circuits.. Each ASHP shall be provided with a BACNet interface to provide as a minimum the following: 1) Be enabled by the automatic control system. 2) Receive a 0-10v input from the BMS to set the flow temperature being controlled by the ASHP's internal control system (between agreed limits). 3) Be monitored for common fault. 4) Be monitored for critical fault. 5) Be interlocked with pumps, flow switch and pressurisation unit. 6) Controls shall be configured to prevent any short cycling of the ASHP's, starts shall be limited to 6 (variable) per hour, programming to take account of any delays built into the integral control system. The ASHP water flow temperature shall be constant to meet the demand of the LPHW heating system. The demand of the LPHW system shall be monitored to determine the number of ASHP's enabled to run, subject to the following overrides from the buffer vessel: 1) ASHP not to operate if buffer vessel water is <='X' degrees warmer than the ASHP flow set point as the thermal store still contains sufficient heating to satisfy the building load. 2) First stage of heating (minimum output) shall be enabled when buffer vessel water is <='Y' degrees cooler than the ASHP flow set point. 3) Next stage of heating shall be enabled when buffer vessel water is <='Y' degrees cooler than the ASHP flow set point. 4) Additional stages of heating from the ASHP's shall be enabled as the buffer vessel decreases by 'Y' degree intervals. 5) As the buffer vessel heats each stage of heating shall be disabled. On re-instatement after power loss to the site the controls shall ensure that excessive inrush is not imposed, each ASHP shall be enabled one at a time with a 5 minute delay between starting each stage. <u>Adjustable Set Points</u> ASHP water flow temperature set point @ 65°C. Where 'X' (buffer vessel temperature below ASHP set point temperature) = 2 kelvin. Where 'Y' (temperature decreases that each stage of ASHP heating is enabled) = 0.5 kelvin.
LTHW to LTHW plate heat exchangers		PHE shall be: 1) Enabled by BMS on heating demand. 2) PHE monitored for run and fault signal by BMS. 3) PHE output controlled by 2-port control valve. 4) Both LTHW flow and return temperatures shall be monitored by the BMS at the LTHW PHEs. Each PHE shall additionally be monitored and provided with: 1) Mechanical interlock provided to guarantee that the flow temperature does not exceed a pre-set temperature. 2) Primary heating pump flow failure to prevent the primary control valve from opening. 3) Hard wired to the pressurisation unit – high pressure shuts down PHEs only and low pressure disables pumps and PHEs.

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AIR TO WATER AIR SOURCE HEAT PUMP SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
		Adjustable Set Points Primary LTHW flow temperature @ 65°C. Primary LTHW return temperature @ 55°C. Secondary LTHW flow temperature @ 63°C. Secondary LTHW return temperature @ 55°C. High limit temperature @ 70°C.
Primary ASHP pumps		A set of run / standby primary side ASHP water pumps shall be provided to circulate water between each of the ASHP's and the buffer vessel as detailed on the schematic. Separate pumps are required for each ASHP to minimise pump energy consumption. Each ASHP pump shall:- 1) Be constant speed type but inverter speed controlled for commissioning. 2) Be monitored for fault via a differential pressure switch. 3) Be interlocked to the ASHP 4) Shall over-run after ASHP is switched off. 5) Duty share and auto changeover on fault shall be provided. 6) Shut down of pumps shall be the reverse of the above taking into account pump over-run times. 7) Be monitored for hours run. 8) Automatically be changed over on a weekly basis. Adjustable Set Points Primary pump overrun – 5 minutes
Secondary distribution pumps		Each pump set individually: 1) Enabled by BMS. 2) Operates on run and standby basis. 3) Monitored for flow for pump fail changeover. 4) For weekly duty changeover for duty wear / sharing. 5) Be monitored for hours run. 6) Has weekly operation during no demand (e.g. summer). 7) Has fully modulating pump speed control based on 0-10V demand signal to match load. 8) Maintains constant differential pressure of system based on pressure differential sensor in each circuit. Pump speed shall be determined by the worst case reading from the pressure differential sensor. Adjustable Set Points Minimum pump differential pressure value.
Pressurisation unit		The pressurisation unit for the ASHP shall be interlocked to the ASHP

M7-19-5 HEATING PERFORMANCE DESCRIPTIONS

HEATING SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
LTHW Pumps	Shunt pumps Primary pumps Secondary pumps	Each pump set individually: 1) Enabled by BMS. 2) Operates on run and standby basis. 3) Monitored for flow for pump fail changeover. 4) For weekly duty changeover for duty wear / sharing. 5) Has weekly operation during no demand (e.g. summer). 6) Has fully modulating pump speed control based on 0-10V demand signal to match load. 7) Maintains either design flow or constant differential pressure depending on location on schematic. 8) Monitor each pump for hours run.

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HEATING SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Pressurisation unit	Heating system	Enabled at all times and not under BMS control. Power fed from local MCC with local isolation only. BMS monitored for the following: 1) Excess run / leak detected (standard alarm). 2) On high pressure alarm disable heat source (critical alarm). 3) On low pressure disable pumps and heat source (critical alarm). Adjustable Set Points Excessive flow through meter – 100 litres in 24 hour time period.
LTHW Thermal store	All	LTHW Thermal Storage provide energy storage to meet peak demands of LTHW system. All stores provided with 6 temperature sensors: 1) High Level Temperature Sensor. 2) 2 Mid-Level (1@33% and 1@66%) Temperature Sensors. 3) Low Level Temperature Sensor. 4) LTHW Return Temperature sensor. 5) LTHW Flow Temperature Sensor. The buffer vessel shall be charged by modulating the LTHW flow to the vessel. The LTHW flow shall be modulated to maintain the store temperature at set point based on the average temperature of all sensors. The charge level of the store shall be automatically adjusted throughout the day such that the store is fully charge at the beginning of the day (before morning boost occurs). The store shall be designed and controlled to achieve the following (listed in order of priority). 1) Ensure adequate heat is available to meet a sustained DHW peak demand. 2) Prevent excessive ASHP demand during peak hot water draw-off periods. The overall control of the charging of the thermal stores is critical for the efficient operation of the heat generating equipment and so the control strategy must be developed and agreed for the detailed design.
Hydraulic Frost protection	Complete system	Two stage frost protection shall be provided: 1) First stage shall be enabled when ambient temperature falls below set point: a) The pumps shall be enabled to operate. b) All secondary two port valves, unless already operating to provide heat, shall be opened to ensure flow throughout the system. c) The system shall remain in this condition until ambient temperature rises to set point plus dead band or related system enters day mode. 2) Second stage frost protection shall be enabled when ASHP low return temperature is reached: a) First stage frost protection shall be enabled, if after the delay period the temperature still remains below set point then the ASHP's shall be enabled. b) The ASHP's shall continue to operate until the upper return temperature is reached when the system will return to first stage frost protection. Adjustable Set Points Ambient set point @ +3°C. Low return water temperature @ 8°C. Delay before 2nd stage – 30 minutes. Upper return temperature @ 35°C.
Electric Trace Heating	External / unheated space pipework	The electric pipe trace heating shall be automatically enabled by the BMS: 1) Enable / disable signal to the trace heating based on ambient. 2) Monitor trace heating for fault signal. Adjustable Set Points Ambient set point to enable trace heating @ +3°C. Ambient set point to disable trace heating @ enable temperature plus 2k.

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HEATING SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Building / fabric protection		Building fabric and contents protected as follows: 1) Series of internal temperature sensors shall monitor the rooms most likely to experience low temperatures. 2) Any internal temperature falls below the minimum temperature set point then heating system enabled at full output until the upper internal temperature reached. 3) The fabric protection routine shall override the frost protection for its corresponding zone. Adjustable Set Points Minimum internal temperature @ +10°C. Upper internal temperature @ +14°C.
Door curtains	Main entrance door curtains	Power feed and BMS control fed from Motor Control Centre Panel. The door curtains shall be fully controlled BMS: 1) Provide enable signal. Enabled by BMS based on external ambient temperature. 2) Temperature controlled output. 3) Monitor for fault. Adjustable Set Points Enabled by BMS based on ambient temperature of 14°C and below.

M7-19-6 DOMESTIC HOT WATER SERVICES DESCRIPTION

DOMESTIC HOT WATER SERVICES SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
HWS calorifiers with integral shunt pumps	HWS Calorifiers	Each HWS calorifier shall: 1) Have LTHW & DHW flow & return temperature sensors. 2) Maintain constant HWS supply flow temperature via modulation of LTHW 2-port control valve. 3) Operate 24 hours per day 7 days per week in order to prevent the risk of Legionella. 4) Be monitored for common fault and running condition via hard wired Volt-free contacts. 5) Be monitored for 2-port control valve position to all rapid charging of thermal stores / activate boost heating mode. 6) Alarm if hot water return below set point. 7) Include a pasteurisation mode – where the whole of the HWS circuit is heated to a higher than normal flow set point temperature for a pre-determined time. 8) De-stratification pump shall be time scheduled to run for a predetermined time period every hour or continuously as client prefers. NOTE: The BMS shall take full control of each electric immersion heater to raise the internal temperature of the cylinders for both 'back up heating' and the pasteurisation cycle. Adjustable Set Points HWS flow temperature set point @ 60°C. HWS return temperature set point @ 50°C. D-stratification pumps shall operate for 5 minutes every 30 minutes / continuously. Pasteurisation HWS temperature set point @ 70°C via electric immersion heater. Pasteurisation time scheduled to begin at 23.00 hours weekly on Sunday evening (when building unoccupied / water use if minimal). Pasteurisation mode enable shall be maintained for 2 hours after the HWS return water temperature has elevated to at least 65/60°C.
HWS circulating return pump	2 HWSR pumps – one installed and one spare.	Enabled by BMS. Monitored for flow and fault condition. Enabled continuously by BMS on a time schedule. Integral variable speed control based on differential pressure (built into pump as very small motor).

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DOMESTIC HOT WATER SERVICES SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
		Each circulation pump shall be terminated to a socket and each pump shall have a short lead with a plug, to allow ease of changeover.

M7-19-7 DOMESTIC COLD WATER SERVICES DESCRIPTION

DOMESTIC COLD WATER SERVICES SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Cold water tanks	All tanks	BMS shall: 1) Monitor cold water tank temperature via midpoint temperature sensor. 2) Alarm when tank has been above set point temperature for 24 hours. 3) Monitor level of tank via level switch for overflow alarm. 4) Monitor level of tank via level switch for sprinkler system low level alarms. 5) Low level switch to hold off booster set enable signal if activated. Switch located to activate when 100mm water remaining. <u>Adjustable Set Points</u> Tank water temperature alarm at 25°C. Tanks temperature exceeded time for 24 hours.
Cold water booster sets		Provided as a packaged unit with integral controls. BMS shall: 1) Provide time scheduled enable signal. 2) Monitor for fault and alarm accordingly. 3) Monitor the actual pressure discharge from the booster set after the pressure reducing valve to provide early warning of any issues. 4) Be hard wired to be held off if the tanks provide low level alarm. 5) Interlocked with sprinkler and associated control system.

M7-19-8 CENTRAL VENTILATION SYSTEMS

AIR HANDLING UNITS GENERAL REQUIRSMENTS	
REQUIREMENT	GENERAL CONTROLS REQUIREMENTS FOR ALL AIR HANDLING UNITS AND HEAT RECOVERY UNITS
Avoid overheating	Overheating caused by the supply air temperature being too high shall be avoided throughout as the air handling units are not intended or proposed to heat any spaces, as this is the role of local emitters / re-heat coils but also the ventilation shall not impose unnecessary heating loads on these same emitters. In heating mode, under normal circumstances the supply air temperature shall be the same and no more than 2 degrees above the room or zone set point.
Free cooling	The air handling units shall be sequenced in operation to maximise the use of ventilation heat recovery and fresh air 'free cooling' before either the heating or cooling coils are activated.
Building pressurisation	Overall under no circumstances, under normal daytime operation, shall extract fans operate to put the building under a negative pressure, the design principle is for the building as a whole to always be under a very slight positive pressure. This pressure should be too low to measure so sensors are not required however the graphical front end should show the total supply of all systems, extract rate for all systems and show the difference in airflow to show that air is always leaking out of the building rather than infiltrating. This statement may be temporarily overridden should one of the supply fans fail and the client determine that operating the services is beneficial.

M7-19-9 VENTILATION SYSTEMS COMPONENT CONTROL STRATEGIES

AIR HANDLING UNITS		
EQUIPMENT	APPLIES	DESCRIPTION
Containment location	Refer to layouts	All externally located air handling units' power, controls and containment to be weatherproof (IP65 as a minimum).
Power feeds to AHU lighting	All AHUs	Bulkhead lighting powered from local MCC automatic control system. Individual circuits for each air handling unit.

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AIR HANDLING UNITS		
EQUIPMENT	APPLIES	DESCRIPTION
Inlet and Exhaust Motorised dampers	Kitchen AHU	Two position open or closed control only. Closed when AHU not enabled. Open when AHU enabled. Proven open by end switch before any fan runs. Proven closed by end switch when fans not running. AHU enabled but end switch not switching to prove dampers open enables alarm.
Heating coils	Kitchen AHU	Electric heater and thermostat shall: 1) Be hard wired/operated through the automatic control system. 2) Be set at 15°C (adjustable)
Supply fans – variable speed	Kitchen AHU	Enabled by BMS. Enable by BMS time schedule and local kitchen control panel. Fans held off until motorised dampers proven open by end switch monitoring. Airflow signal proven utilising pressure differential switch. Delay of fault for 30 seconds (adjustable) on start up. No signal after 30 seconds then airflow failed alarm. Variable speed controlled fans shall modulate to ensure constant duct pressure via pressure sensors. Single fan to provide variable airflow between 40% and 100% design capacity. Fan speed modulation via motor inverters. Differential pressure sensor to prove airflow and provide an indication of 'healthy' airflow to BMS. Airflow signal proven utilising pressure differential sensor. Delay of fault for 30 seconds (adjustable) on start up. No signal after 30 seconds then airflow failed alarm. Differential pressure sensor to prove airflow and provide an indication of 'healthy' airflow to BMS. Design airflow set point to be achieved determined at commissioning stage for design static pressure. Hard wired to operate same time as the kitchen extract fan – failure of supply fan airflow disables extract fan / failure of extract fan airflow disables supply fan. All motors shall be monitored for hours run.
Filters	Kitchen AHU	Pressure differential sensors to monitor differential pressure loss across filters. All filters alarm to BMS when pressure loss reaches a pre-set loss. Pre filters alarm on rapid increase in pressure loss as indicates frozen filter - automatic reset of alarm when pressure loss reduces to previous non-frozen condition.
Design Parameter Overview	Kitchen AHU	Supply air temperature control only – straight line graph variable based on external ambient: To maintain constant supply air temperature 15°C (adjustable)

LOCAL HEAT RECOVERY UNITS (HRUS)		
EQUIPMENT	APPLIES	DESCRIPTION
Inlet and Exhaust Motorised dampers	All	Two position open or closed control only. Closed when HRU not enabled. Open when HRU enabled. Proven open by end switch before any fan runs. Proven closed by end switch when fans not running. AHU enabled but end switch not switching to prove dampers open enables alarm.
Plate heat exchangers	All	Fully modulating face and bypass dampers to maximise heat recovery. All fully adjustable from 0-100% for total compliance with EU Regulation No. 1253/2014. Provide 1st stage of either heating or free cooling depending on the mode of operation. Monitor all heat recovery for %age bypass.

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LOCAL HEAT RECOVERY UNITS (HRUs)		
EQUIPMENT	APPLIES	DESCRIPTION
		Monitor all heat recovery systems for supply side on and off temperature.
Heating coils	All	Electric heater and thermostat shall: 1) Be hard wired/operated through the automatic control system. Be set at 18°C (adjustable)
Supply fans	All	Enabled by BMS. Enable by BMS time schedule and local control panel. Fans held off until motorised dampers proven open by end switch monitoring. Airflow signal proven utilising pressure differential sensor. Delay of fault for 30 seconds (adjustable) on start up. No signal after 30 seconds then airflow failed alarm. Differential pressure sensor to prove airflow and provide an indication of 'healthy' airflow to BMS. Variable speed controlled fans shall modulate to ensure constant duct pressure via pressure sensors (one per AHU system). Single fan to provide variable airflow between 40% and 100% design capacity. Fan operation shall be proven by monitoring inverter and CT's on fan supplies - if the respective proven signal is not achieved after a 30 second (adjustable) start up period then fan fail alarm. Design airflow set point to be achieved determined at commissioning stage for design static pressure. Hard wired to operate same time as extract fan – failure of supply fan airflow disables extract fan / failure of extract fan airflow disables supply fan. All motors shall be monitored for hours run.
Extract fans	All	Monitored and controlled as per supply fans. Airflow adjustment to track supply fans.
Filters	All	Pressure differential sensors to monitor differential pressure loss across filters. All filters alarm to BMS when pressure loss reaches a pre-set loss. Pre filters alarm on rapid increase in pressure loss as indicates frozen filter (when ambient less than 3°C) - automatic reset of alarm when pressure loss reduces to previous non-frozen condition.
Design Parameter Overview	All	Maximise free cooling when required. Heating coil set to provide constant set point supply temperature unless free cooling required. Manufacturers packaged control systems may be used providing the above strategy can be achieved.

M7-19-10 DIRTY EXTRACT FANS

DIRTY EXTRACT FANS		
EQUIPMENT	APPLIES TO	DESCRIPTION
Local wall / ceiling mounted extract fans	All	Packaged dirty extract fan sets with fully integrated controls. BMS shall: 1) No requirement. Packaged controls shall be by the manufacturer and generally provide the following: 2) Enabled fan as part of adjustable time schedule. 3) Operate on on demand basis with off / trickle and boost modes with integrated or ceiling mounted PIR to provide the required design airflow set points determined at commissioning stage. Monitored for fan trip signal.

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M7-19-11 ENERGY METERING

ENERGY METERING SYSTEM		
EQUIPMENT	APPLIES TO	DESCRIPTION
Energy Meters	Main LV Panel Electrical Meters (provided by the LV manufacturer) Incoming Cold Water Services All heat meters.	Refer to '**Section 4 – Energy Metering**' specification section for the specific energy metering requirements that are required to be included as part of the overall BMS design, installation, testing and commissioning. On this project the BMS Contractor shall provide all necessary meters, except for the LV panel electrical meters, to achieve a fully compliant energy metering system.

M7-19-12 HUB, IT AND COMMS ROOMS COOLING

DIRECT EXPANSION COOLING ONLY SYSTEMS		
EQUIPMENT	APPLIES TO	DESCRIPTION
DX Systems	ALL	Monitored by BMS only: 1) Fault signal from each DX system. 2) Room temperature monitored for increase in room temperature. 3) If no fault signal and room temperature not exceeding set point value then report 'no fault' signal. Adjustable Set Points Alarm signal when room temperature exceeds 25°C.

M7-19-13 TRACE HEATING SYSTEMS

REFRIGERANT LEAK DETECTION SYSTEMS		
EQUIPMENT	APPLIES TO	DESCRIPTION
Trace Heating Systems	LTHW trace heating system. MCWS trace heating system.	Power supply fed via local motor control centre. Monitored and adjusted by BMS: 1) Fault signal from each heating system. 2) Monitored for no fault condition. 3) Enabled by adjustable ambient sensor. 4) Always monitored. 5) Trace heating self-regulating once enabled. Adjustable Set Points Trace heating enabled by ambient sensor when ambient at 5°C or lower.

M7-19-14 VRF/VRV HEAT PUMP SYSTEMS

HEAT PUMP SYSTEMS		
EQUIPMENT	APPLIES TO	DESCRIPTION
VRF / VRV Systems	All	Monitored and set point adjustment via BMS BACNet with all other local controls provided by the integral controls: 1) Room sensor provided for each indoor unit for local zone control. 2) Each indoor unit enabled by BMS based on BMS adjustable set points. 3) User adjustable set point dictated by BMS for higher and lower room user adjustment (users cannot override BMS dead band values). 4) Automatic reset temperature to default values at predetermined time (set point temperature and time reset by BMS). 5) Each indoor unit monitored by BMS for fault. 6) Each outdoor unit monitored by BMS for fault. Adjustable Set Points Default cooling enabled temperature @ 24°C. Default cooling reset time – midnight. User adjustment values between 21°C and 25°C.

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M7-19-15 LIFT FAULT MONITORING

LIFT FAULT MONITORING		
EQUIPMENT	APPLIED TO	DESCRIPTION
Passenger and Goods Lifts	Each lift provided in this project	Each lift control shall be provided with a volt free contact to provide remote monitoring of the lift for a common fault signal. BMS shall be wired to each VFC for individual fault signals.

M7-20 MOTOR CONTROL PANELS

The work covered by this section of the specification details additional requirements associated with the Control Panels required as part of the overall Automatic Controls (Building Management System) works.

The control panels shall be suitable for use with a nominal system voltage of 400 volts phase/phase with variations of + 10%, - 6% from the supply authority, and a further maximum volt drop on the Client's installation of 4%.

All equipment, including any proprietary or other components, must be suitable for use in the site conditions.

The system control panels shall be provided with microprocessor direct digital controllers complete with battery back-up for 72 hour duration and integral on line UPS (4 hour on line) and outstation and central graphic p.c. to monitor interrogate all equipment, sensors etc.

M7-20-1 CONTROL PANEL CONSTRUCTION

The panel shall be two compartments with one utilised for controls (all less than 110V) and one for power. The compartments shall be housed in two completely separate sections to reduce the risk of fire damage. The equipment shall comprise of a damp and dust protecting, vermin proof, sheet steel housing, framed and braced as necessary to form a rigid structure for floor or frame mounting suitably ingress protected to suit the panel location.

Specifically, control panels shall be rated at IP31 where located internally and IP65 or better where located externally or not fully weatherproof enclosure.

Except where the front cover forms part of draw-out equipment, hinged doors permitting unrestricted access to the interior, shall be provided for all compartments requiring entry for routine inspection or to perform manipulation functions during normal use of the equipment. Elsewhere bolted covers for compartments are required. The limit of travel of opening of doors must be positively controlled, and in no case shall there be fouling of items such as switches, instruments, relays, indicator lamps etc., mounted on adjacent panels or on the door being opened.

Flexible wiring to items mounted on hinged doors must not be subjected to strain or kinking when the door is moved. Any through wiring between compartments shall be so arranged or protected that abrasion of insulation cannot occur.

Where cut-outs may be necessary for the fitting of items in sheet steel panels or doors, adequate rigidity must be preserved, with additional stiffening for the purpose where necessary.

The main MCC shall be suitable for extension at one end. Confirm with Engineer preferred end before construction.

All components of the same design shall be interchangeable.

Each control panel shall have an anti-condensation heater.

M7-20-2 INTELLIGENT PROGRAMMABLE OUT-STATIONS

The outstations shall be an integral part of the relevant control panel and shall be of a suitable size to undertake all the functions specified.

Although forming part of the main control panel the outstation shall be fully accessible such that isolation of the motor control panel is not required in order to gain access to the outstation.

Each outstation shall be of the fully intelligent type containing its own microprocessor, power supply and programmes to handle measurements, alarms, quantity counting, single and multi-stage commands and remote set point commands. Inputs and outputs shall be capable of interfacing with standard industrial signals i.e. 0-10V, 2-10V, 0-1mA, 4-20mA, NI200, NI1000, PT130, POT130, OHM, POT 2.5k OHM.

The programs contained within the outstation shall give full DDC which shall be programmable on site without the knowledge of any process language by the user. The DDC shall consist of all normal H & V control loops such as P, P+I, P+PI, schedules, shifts and limit values. All loops shall be fully integrated to give complex control functions. These shall be constructed into simple software modules to give user definable logic controls such as sequence start, auto change over and system interlocking etc.

In the event of a power failure the out-station must retain its memory for a period of 72 hours and be capable of normal operation for a period of 3-6 hours. If this period is exceeded than all parameters must be retained and automatically reloaded when power returns.

No main voltages, other than a shielded power supply, shall be present at the outstation. All commands and Status/Alarm signals shall be limited to 24 Volt. Interface relays shall be incorporated at the point of mains voltage.

Each outstation shall be capable of performing its control, monitoring and alarm function of a standalone basis. It shall be independent in operation and of other system components. Each out-station shall be self-diagnosis and shall be capable of storing and recording all faults and alarms.

M7-20-3 EARTHING

A copper earth bar, of section appropriate to the system prospective fault level, and equipment Class, shall be provided, extending along length of the MCC. The jointing techniques applied to the earth bar shall be to the same standard of construction of those of the bus bars as described for the LV switch panels within this Employer's Requirement Specification.

Lugs for external connections shall be provided and fitted towards each end of the earth bar.

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All non-current carrying metal parts of the equipment must be bonded to this earth bar. Metal cases of instruments, relays and the like shall each have an earthing wire, and in no event must reliance be placed on hinges of doors as constituting an earth part for such items. Earthing connections of wiring shall be taken to the earth bar via a removable bolted link or easily removable connection in each instance.

Gland plates or cable boxes and their mounting shall be so designed and constructed as to provide or permit an effective earth path for the armouring and/or metal sheaths of external cables. Painted surfaces or gaskets must not interpose in the earth path of such items, and additional bonding connections are required as may be necessary to avoid this.

M7-20-4 PADLOCKING

Provision for padlocking is to be available for safety shutters, isolating switches, cubicle doors, and any operating handles or mechanisms where necessary.

M7-20-5 PHASE COLOURING

Phase colours are to be marked for all main connections, and as necessary for ancillary wiring.

Whilst the standard colours and phase progression are Brown, Black, Grey, colouring must not proceed without prior confirmation from the Engineer.

All phase colourings must be painted, plastic sleeved, taped or otherwise permanently marked by means which are non-deteriorating.

M7-20-6 WIRING IDENTIFICATION

All wiring of equipment must have a numbered ferrule, bearing the same one identifying reference at each end and along every branch of any one connection. Such numbers attributed to any one wire in a particular unit must each be unique and carried out to a co-ordinated system throughout.

The numbers used, together with wire references provided by the Engineer for connections to other equipment, must appear on the diagrams. Where connections are made to proprietary items having standard terminal block numbering then the wire numbers and the associated terminal numbers are both to be shown on the comprehensive diagrams.

For D.C. supply circuits the symbols + and - must be used throughout in addition to any other references.

M7-20-7 LABELLING

All components whether mounted on external surfaces or internally, including instruments, switches, control handles, push buttons, contactors, relays, resistors, terminals, fuses and other devices, must have identifying labels or references either on or adjacent to the items in question.

It is not considered sufficient that, for example, a proprietary relay shall bear only the maker's reference 'XYZ Relay', and a further label for function identification is required in such cases.

Circuit titles for compartments are required on the front door or cover, and on the equipment within the compartment as may be necessary, also on the rear where cable terminations or covers require this. All bolted covers whose removal gives access to 'live' parts shall have warning labels fitted.

Labels are preferred in laminated plastic with black lettering on a white ground, except for any 'danger' labels where red letters on a white background are preferred.

All labelling of internal components where the use of laminated plastic may not be practicable must nevertheless be marked and legible manner. Where use of adhesive labels is contemplated care is essential to ensure that the long term adhesive properties are suited to the surface and other conditions of application.

M7-20-8 CABLE BOXES AND GLANDS

For all items of equipment, cable sealing boxes with glands, compression glands and gland plates, must be provided and fitted as necessary.

Where external cables are plastic insulated, (as distinct from impregnated paper insulated), sealing boxes shall still be required if the clearances from live parts, either between phases or to earth would otherwise be insufficient. The manufacturer is to advise the recommended quantity and grade of sealing compound.

The types and details of cabling attachments shall be subject to prior comment by the Engineer.

Gland plates must be sufficiently above the base of the cubicle, according to the size of cable, to facilitate making-off cables, and without impeding access to other equipment. Attention is particularly drawn to that fact that, where the use of cables having aluminium conductors is specified, increased space requirements may be necessary because of the larger dimensions as compared with copper conductors.

M7-20-9 TERMINATIONS AND CABLE SOCKETS

Terminals for multi-core and control cabling must each be of size suitable for receiving not less than two cores consisting of 2.5mm^2 conductors. Where more than two cable cores are required to be connected, looping terminals must be provided.

On multi-way terminal boards not less than 20% spare ways must be provided.

Cable lugs suitable for crimped termination of external cabling are to be provided and fitted throughout for all power cables with conductors up to 185mm^2 except where any special cases are drawn to the attention of, and agreed with the Engineer. For cable conductors larger than 185mm^2 sweating sockets are required. The types of lugs in each case are to be agreed with the Engineer prior to commitment to purchase or supply.

The minimum size of conductor to be used shall be 1.5mm^2. The minimum size used for internal flexible wiring is preferred as 1.5mm^2, but in any case shall not be less than 1.0mm^2. Terminals must be suitably disposed in relation to the floor or base of the compartment and/or the gland plate(s) to facilitate ready connection of cables without impeding access to other equipment.

Terminals must not be of a type relying on the pressure of a screw in direct contact with the conductor.

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M7-20-10 FOUNDATIONS

Foundation bolts and any sub-frames or other metallic foundation materials necessary for mounting and alignment of the MCC and ancillary equipment on prepared concrete, are to be specified and provided by the manufacturer.

All panels shall be fixed to the structure to ensure they are rigidly supported and cannot topple.

All panels must be designed to be self-supporting and not rely on the building walls for support.

M7-20-11 PANEL COMPONENTS AND FEATURES

ITEM	DESCRIPTION
Circuit Breakers	Each circuit breaker on the MCC shall be of the air-break, trip free, triple pole type, with additional pole or neutral link where required. Circuit breakers shall comply with industry standards including those listed in 'Standards Applicable' and must have been tested at an approved testing station to confirm that short circuit capacity and the rated breaking capacity (Ics) shall be at least 50kA rms for O-CO-CO cycle. Every circuit-breaker must have a mechanically operated direct acting trip device which is always available for emergency tripping of a breaker which is closed and in its 'service' (normal duty) position. Whenever a circuit breaker is in any other than its normal service position, every means of initiation not at the circuit breaker must be rendered inoperative.
Isolating switches	All isolating switches shall be capable of breaking not less than the rated continuous current of the circuit being fed through that switch, and of making on to a three phase bolted fault when fuses of the appropriate rating are in position. Fuse switches shall be of double break pattern, with the fuse links mounted on the moving carrier. With the switch open, the fuse links shall be disconnected from the supply and load circuits and so arranged such that fuse replacement is readily possible without danger of contact with 'live' parts. All motor circuit isolating switches shall be capable of interrupting stalled motor current. All isolating switches shall be mechanically interlocked so that access to the interior of a compartment cannot be obtained unless the isolator is in the off position, and the main supply within that compartment is removed. Any parts of the isolator which remain 'live' must be completely shrouded to prevent accidental contact by personnel when the compartment is open. Where this may not be practicable in any particular instance, then the 'live' supplies remaining must be completely shrouded with warning labels fitted as required. The details of all such arrangements must be submitted to the Engineer for approval prior to commitment to manufacture.
Fuses	All fuses, including those for control circuits, must be of HRC type of appropriate class. Wiring to fuse holders and the fixed contacts of removable fuses must be shrouded to prevent accidental contact with live parts.
Auxiliary Switches, Contacts and Indication	Auxiliary switches are to be provided whether for circuit breakers, contactors or isolating switches. These switches (for contactors these may be termed 'auxiliary contacts') are to cater both for correct operation of the main switching device, and also for signals associated with remote equipment for interlocking, alarm and indication, as necessary. Where insufficient auxiliaries are available, then a reliable repeat relay, or relays, must be provided. Spare auxiliary switches are to be provided with each circuit breaker to give at least one normally open and one normally closed way for each circuit-breaker position. A common 'lamp test' push-button shall be provided for all indication lamps.
Miniature and Moulded Case Circuit Breakers	MCB's or MCCB's ratings and breaking capacity must always exceed the fault level that can occur. In suitable circumstances fuses shall be fitted in the live side of the switching device for the purpose of limiting the I^2t let through. The operating characteristic of the highest fuse rating which can be fitted (not necessarily the rating of fuse which shall be fitted) must, in all cases, cross the operating characteristic of the breaker at a point within the breaking capacity of the latter.
Lamps	All lamps shall be LED type as follows: • Colours as scheduled below. • Restriction of Hazardous Substances Directive (2002/95/EC) (ROHS) compliant. • Ingress protection (IP) 65 rated. • Minimum life expectancy of 30,000 hours. • 22mm diameter lamp. • Same lamp model for all bezel colours. • Same diameter as all panel mounted switches. For appearance and performance as per:

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ITEM	DESCRIPTION
	• Schneider Electric XB4 Series. • Multicomp 22mm Pilot LED lamps Series. • Tranilamp JY 22.5mm Series.

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M7-20-12 CONTROL PANEL LAMP INDICATION AND SWITCHING REQUIREMENTS

ITEM	LAMP INDICATION	CONTROL SWITCH PROVISION
For Each Fan	Fan Running (Green) Fan Airflow Failure (Red) Fan Thermal Overload Trip (Red)	Auto/Off/Hand Switch
For Each Motorised Damper	Shut Off Damper Failure (Red) (BMS monitors dampers' end switches)	None
For Each Air Handling Unit	Supply Fan Running (Green) Return Fan Running (Green) Airflow Failure - Return Fan (Red) Airflow Failure - Supply Fan (Red) Supply Fan Thermal Overload Trip (Red) Return Fan Thermal Overload Trip (Red) Frost Thermostat Alarm (Red) Filter Dirty Indicator (Orange) Heat Recovery Active (Green) Heat Recovery Failed (Red)	Auto/Off/Hand Switch for EACH Fan
For Each Cooling Air Conditioning System	Room Cooling Unit Failure (each) (Red) (via Room Temperature Sensor)	None
For Each ASHP / Chiller	For Each Chiller: Chiller Enabled (White) Chiller Running (Green) Chiller Fault (Red)	Auto/Off/On switch for each chiller On shall enable the chiller for manual override and testing purposes.
For Each Pressurisation Unit	Pressurisation Unit Power (White) Common Fault (Red)	None
For Each Pump (and Set) (Including DHWSR pump).	Pump Set Water Flow Failure (Red). One pressure differential switch per pump set. Pump Thermal Overload Trip (Red) Pump Running (Green)	Auto/Off/Hand switch for EACH pump
For Each Hot Water Generation Equipment whether Heating or HWS	High Temperature Limit (Red) Low Temperature Limit (Red) Within design tolerances (Green)	None
For Each Water Booster Set	Water Booster Set Enabled (Green) Common Fault Alarm (Red) Disabled (White)	Auto/Off/Hand selector switch
For high limit valve	System Operation Normal (Green) Activation of high limit valve (Red)	None
For Safety Valves for each area to enable maintenance to locate problematic valve.	Activation of safety valve (Red)	None
For Each Water Tank	High Water Level (Red) Low Water Level (Red)	
For Each Panel	Panel live lamp. Fire Alarm Condition Lamp (Red).	Door interlocked isolator. Lamp test button.

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Section M9

Fire Fighting Systems

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M9-1 GENERAL REQUIREMENTS

This Section of the Specification identifies general requirements associated with the installation of the Fire Fighting Systems. This project includes the following firefighting systems:

1) Domestic / residential sprinkler system(s).
2) A new underground fire hydrant main shall be installed as described in the Enabling Section of this specification.

M9-2 DEFINITIONS

Refer to Section 1B for general definitions and as below:

DEFINITIONS			
AFFL	Above finished floor level	BAFSA	British Automatic Fire Sprinkler Association
AHJ	Authority Having Jurisdiction	PRV	Pressure Regulating Valve

M9-3 REFERENCE TO OTHER SECTIONS OF THIS SPECIFICATION

This section of the specification shall not be used in isolation and must be read in conjunction with the particular sections, commissioning and standard clauses, all of which define further the requirements for the natural gas installations.

M9-4 STANDARDS APPLICABLE

Works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below:

DOMESTIC SPRINKLER STANDARDS	
British Automatic Fire Sprinkler Association Guidelines, Codes of Practice and Information Files, in particular Information File 'Wet and Dry Risers Designed to BS9990' Issue 2 BIF No. 21	BS EN 10240 Internal and/or external protective steel coatings for steel tubes
BS 336 Specification for fire hose couplings and ancillary equipment	BS EN 10255 Non-alloy steel tubes suitable for welding and threading
BS 5041 Fire hydrant systems equipment	BS EN 13501 Fire Classification of construction products and building elements
BS 5499 Guide for the selection and use of fire safety signs and fire safety notices	Building Control Officer requirements
BS 7974 Application of fire safety engineering principles to the design of buildings	Building Regulations, in particular AD Part B
BS 8519 Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications	CIBSE Design Guides, in particular Guide E – Fire safety engineering
BS 9251 Sprinkler systems for domestic and residential occupancies	Fire Advisor requirements
BS 9990 Non automatic fire-fighting systems in buildings	Fire and Rescue Services Act
BS 9991 Fire safety in the design, management and use of residential buildings	Fire Safety Order
BS 9999 Fire safety in the design, management and use of buildings	Healthcare Technical Memoranda (HTM), in particular HTM 05-02

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Where discrepancy is found between this specification and the relevant standards, the Contractor shall obtain written clarification from the Engineer prior to submission of the tender. Where a discrepancy has not been clarified prior to tender submission, the Contractor shall include the most onerous requirements.

M9-5 SCOPE OF WORKS

The following brief description lists the firefighting systems required for installation on this project. Comprehensive system(s) requirements are detailed in subsequent clauses of this specification together with schematic and tender drawings. The firefighting system(s) installations shall include for all plant, equipment and labour to carry out the design (where necessary), supply, installation, testing, commissioning and setting into operation of the following works.

1) Domestic / Residential Sprinkler System(s).
2) All necessary system(s) purging, testing and commissioning.
3) All primary and secondary support systems to install the services.
4) Design development and coordination of the tender information to fully detailed working or installation drawings. This shall include responsibility for the following areas:-
   a) Support systems/brackets for all services.
   b) Expansion and contraction within the system networks.
   c) Final co-ordination of the mechanical and electrical services including the preparation of completely dimensioned double line services fabrication drawings.

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d) Development of the Consultants' details for equipment specified to achieve the criteria described within the tender documents.

e) Development of the controls specification for the hardware, software, power, controls wiring and all associated equipment.

5) Liaise with all other trades.

M9-6 GENERAL DOMESTIC / RESIDENTIAL SPRINKLER SYSTEM REQUIREMENTS

The domestic sprinkler system shall be design, installed, tested and commissioned to serve the residences on this project.

The sprinkler system shall be complete with:

- Adequately sized cold water storage tanks.
- Booster pump set.
- Separate riser mains in riser(s).
- Fully concealed zoned distribution pipework.
- Sprinkler heads to achieve the required category protection.
- All alarms must be agreed with design team and AHJ and integrated with the fire alarm system.

M9-7 DOMESTIC / RESIDENTIAL SPRINKLER SYSTEM DESIGN PARAMETERS

The domestic sprinkler installation will be designed, installed, tested and commissioned by the sprinkler specialist in accordance with the documents listed in 'Standards Applicable' plus the following additional or particularly relevant requirements:

1) BS 9251 – Fire sprinkler systems for domestic and residential occupancies – Code of Practice.

2) BS 9252 – Components for residential sprinkler systems – Test methods and specifications.

3) Underwriters Laboratory Standard UL 1626 – Residential Sprinklers for Fire Protection Service (until BS 9252 – Components for residential sprinkler systems certified sprinkler heads are available).

4) BAFSA Advisory Comments detailed in BAFSA Information File No. 2 'Fire sprinkler systems in Dwellings'.

5) BAFSA Advisory Comments detailed in BAFSA Information File No 8C 'Sprinkler heads'.

6) BAFSA Advisory Comments detailed in BAFSA Information File No 8D 'Fire sprinkler systems and the use of CPVC plastic piping'.

7) BAFSA Advisory Comments detailed in BAFSA Information File No 14 'Fire sprinkler systems in Care Homes'.

8) BAFSA Advisory Comments detailed in BAFSA Information File No 18 'Fire Sprinkler Systems in Timber Frame Buildings'.

9) BAFSA Advisory Comments detailed in BAFSA Information File No 20 'Third Party Certification'.

10) BAFSA Technical Guidance Note No. 1 'The Design and Installation of Residential and Domestic Sprinkler Systems'.

MANDATORY FINAL DESIGN REQUIREMENTS

The designer and installer shall be fully certified in accordance with Loss Protection Standard (LPS) 1031. Only companies listed in the LPCB List of Approved Fire and Security Products and Services, known as the Red Book, certified with LPS 1301 shall be permitted on this project.

LPS 1301 certification is required to satisfy the requirement of BS 9251 that the contractor is suitably 'qualified and experienced'.

On completion of the installation a 'Certificate of Conformity' in accordance with BS 9251 shall be issued.

Should the design not be fully in compliance with BS 9251, such as the installation being installed in a building greater than 45 metres, all deviations shall be agreed in writing with the Engineer at the design stage.

Specific operational design parameters to be achieved:

1) Include any particular requirements of 'Authorities Having Jurisdiction' as detailed in clause 4.2 of BS 9251.

2) A Category 3 under BS 9251 shall be provided to all relevant areas.

3) Domestic sprinkler system shall be provided with water storage tanks of sufficient capacity to meet the Category 3 water supply or enhanced requirement if determined necessary. The tank capacity shall allow for the higher flow rate through most favoured heads to ensure the required duration of sprinkler operation is achieved.

4) Domestic sprinkler system shall be provided with two pumps, operating as run and standby, to meet the maximum peak flow rate defined for Category 3 output, or as required by the sprinkler heads whichever is the greater. Both flow and pressure required by the pump duty shall be at the least favoured / index sprinkler(s) heads. Even if the sprinkler heads can operate at less than 0.5 Bar Gauge it is a requirement that a minimum of 0.5 Bar Gauge is provided at the index head (to allow for future replacement of sprinklers heads over the life of the building).

5) For hydraulic calculations and pump selection all, including the index, sprinkler heads shall be designed to allow to operate at a minimum of 0.5 Bar even if the actual sprinkler head selected will operate satisfactorily at a lower pressure.

6) Sprinkler coverage for tender shall be fully in accordance with BS 9251. Alternative coverage allowances based on the actual sprinkler performance shall not be considered unless stated in these 'Specific operational design parameters'.

7) All recommended documentation listed in BS 9251 shall be provided.

8) The sprinkler installation shall be registered with the local water authority at the design stage as this is a legal requirement.

M9-8 DOMESTIC / RESIDENTIAL SPRINKLER STORAGE TANKS

Refer to section M1 for details of the combined potable and domestic sprinkler tanks.

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M9-9 DOMESTIC / RESIDENTIAL SPRINKLER PUMPS

Refer to section M1 for details of the combined potable and domestic sprinkler booster pump set.

M9-10 DOMESTIC / RESIDENTIAL SPRINKLER BACKFLOW PREVENTION

The branch / system that feeds the sprinkler system shall be provided with backflow prevention fully in accordance with the Water Supply (Water Fittings) Regulations and WRAS Water Regulations Guide.

M9-11 DOMESTIC / RESIDENTIAL SPRINKLER PRIORITY DEMAND VALVE

Refer to section M1 for details of the priority demand valves.

All branches that feeds the sprinkler system shall be provided with priority demand valve to divert all water flow and pressure to the sprinkler system from the normal domestic use. This priority valve is required to operate on activation of any sprinkler head and flow being detected.

M9-12 DOMESTIC / RESIDENTIAL SPRINKLER PIPEWORK, FITTINGS AND VALVES

The sprinkler pipework, fittings and valves shall be fully compliant with BS 9251 and therefore may be copper, carbon steel or CPVC, such as Blazemaster.

Where Blazemaster is proposed the use must allow for the peak operating pressure of this material is 12 Bar Gauge.

The pipe support centres shall be as recommended by the pipework manufacturer where available or as listed in BS 9251. Pipe support centres listed in BS 9251 supersede those listed in the section 2 standards of this specification.

M9-13 SPRINKLER PIPEWORK FIRE STOPPING

Where CPVC pipework systems are installed, then it is critical that only fire stopping materials approved by the pipework manufacturer are used for fire stopping around pipework penetrations, as normal intumescent mastic may soften the pipe material.

M9-14 SPRINKLER HEADS

Although sprinkler heads should be compliant with BS 9252 and the forthcoming BS EN 12259-14 until these are available the sprinkler heads shall be complaint with industry standard listed.

All sprinklers installed on this project shall be recessed standard design / recessed vandal resistant design.
Only residential type sprinkler heads shall be permitted in habitable rooms / areas of the building.
On systems that are piped using CPVC pipework no sprinkler head shall have a temperature rating greater than 74°C as recommended by BAFSA.

M9-15 TESTING AND COMMISSIONING

On completion the entire installation shall be pressure tested to at least 8 Bar Gauge or 1.5 times peak design working pressure for at least one hour.

Following a satisfactory pressure no leak test each branch shall be flow rate tested in accordance with both BS 9251 and BAFSA recommendations.

M9-16 SPRINKLER ELECTRICAL INSTALLATION

The Sprinkler Contractor shall ensure that the electrical installation associated with the sprinkler installation is fully tested and commissioned in accordance with the Standards Applicable listed previously. All test data shall be recorded in the format listed in the testing and commissioning section of the Electrical Specification. The Sprinkler Contractor must fully acquaint himself with these documents prior to undertaking any of the testing.

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couchperrywilkes
engineering change

BRACKLEY
PROPERTY DEVELOPMENTS

64 Bed Care Home
Crookthorn Lane, Climping, Littlehampton

200422

Mechanical Services Tender Analysis

DOCUMENT REVISION HISTORY			Ref:	200422
Rev	Author	Verification By	Date	Comments / Status
T1	C Marshall	C Waldron	25/09/20	Tender Issue

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1-0 PROJECT TENDER COSTS

PROJECT TENDER COSTS				
Item		Description	Item Cost	Section Cost
1	For all costs associated with Section 1 – Preliminaries			
	a)	General requirements	£	
		Section Total	£	£
2	Standards Installation Clauses			
2A		For all costs associated with Section 2A - General Installation Clauses - Pipework	£	
2B		For all costs associated with section 2B - General Installation Clauses - Ductwork	£	
2C		For all costs associated Section 2C – General Installation Clauses - Mechanical Commissioning	£	
2D		For all costs associated Section 2D – General Installation Clauses – Thermal Insulation	£	
2E		For all costs associated Section 2E – Electrical Workmanship and Materials	£	
2F		For all costs associated Section 2F – Electrical Inspection and Testing	£	
		Section Total	£	£
3	For all costs associated Section 3 – Site Specific Requirements			
	a)	12 months planned & corrective maintenance including consumables	£	
	b)	Mechanical	£	
		Section Total	£	£
4	For all costs associated with Section 4 – Energy Metering			
		Section Total	£	£
5	For all costs associated with Section 5 – Enabling and Incoming Services Works			
	a)	Incoming Main Cold Water supply	£	
	b)	Mechanical Enabling works (Stripping Out/Re-routing works)	£	
	c)	Fire Hydrant system	£	
	d)	Other	£	
		Section Total	£	£
6	For all costs associated with Section 6 – Design Standards			
	a)	Mechanical	£	
		Section Total	£	£
M1	For all costs associated Section M1 – Domestic Water Services			
	a)	Generation plant & Equipment (ie Plate heat exchanger, Calorifiers, Pumps etc)	£	
	b)	Storage and Break Tanks	£	
	c)	Domestic Water distribution systems	£	
	d)	Cat 5 distribution systems	£	
	e)	Other	£	
		Section Total	£	£
M2	For all costs associated Section M2 – Heating			

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PROJECT TENDER COSTS				
Item		Description	Item Cost	Section Cost
	a)	Heat Generation Plant (ASHP's, Pumps, Pressurisation sets, Thermal Storage, Plate heat exchangers etc.)	£	
	b)	LTHW distribution system(s)	£	
	c)	Other	£	
		Section Total	£	£
M3		For all costs associated Section M3 – Mechanical Ventilation Systems		
	a)	Kitchen Air Handling Units	£	
	b)	Kitchen Extract Fan and System	£	
	c)	Laundry Specialist Supply and Dryer Exhaust Systems	£	
	d)	Laundry General Supply and Extract System	£	
	e)	General Ventilation Extract and Heat Recovery Ventilation		
	f)	Galvanised Ductwork distribution systems	£	
	g)	Fire Stopping Including Fire Rated Ductwork Systems.	£	
	h)	Attenuators	£	
	i)	Other	£	
		Section Total	£	£
M5		For all costs associated Section M5 – Cooling Systems		
	a)	Variable Refrigerant Flow (VRF) system	£	
	b)	Direct Expansion (DX) system	£	
	c)	Other	£	
		Section Total	£	£
M6		For all costs associated Section M6 – Drainage		
	a)	Drainage associated with domestic area systems	£	
	b)	Plantroom drainage system	£	
	c)	Other	£	
		Section Total	£	£
M7		For all costs associated Section M7 – Controls/BMS System		
	a)	All MCC's equipment and wiring	£	
	b)	Field wiring(power & control) and equipment(Variable speed drives, sensors etc)	£	
	c)	Interface with Process Control systems (ie Laboratory VAV system, or Pressure Regime systems, or HMI's)	£	
	d)	Other	£	
		Section Total	£	£
M9		For all costs associated Section M9 – Fire Fighting – Sprinklers		
	a)	Domestic sprinkler system	£	
	b)	Other	£	
		Section Total	£	£
		For any other mechanical costs not detailed above, add description / cost below:		

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PROJECT TENDER COSTS				
Item		Description	Item Cost	Section Cost
	A		£	
	B		£	
	C		£	
		Section Total	£	£
		SUB TOTAL CARRIED FORWARD TO TENDER SUMMARY		**£**

2-0 PROVISIONAL SUMS

PROVISIONAL SUMS			
Item	Description	Item Cost	Section Cost
1)			
2)			
3)			
4)			
5)			
	Sub Total	**£**	£
	SUB TOTAL CARRIED FORWARD TO TENDER SUMMARY		**£**

3-0 SCHEDULE OF DAY WORK RATES

Work agreed to be carried out as daywork will be paid for at the following rates and such payment will only be for the net time worked on the Site. The rates are to include for overheads and profit, all supervision (being the cost of full-time foremen or additional rates paid to chargehands etc.), insurances, holidays with pay, bonus, pension schemes, subsistence allowances, fares and travelling time, imported labour costs, non – productive overtimes costs, tools of all descriptions and other payments made under the Working Rule Agreement or any Regulation, Bye-law or Act of Parliament.

The total of this Daywork Schedule shall be expended or deducted in whole or in part as directed by the Architect.

The Tenderer is to insert against the hours shown the hourly rates required, calculated in accordance with the above, for the various categories of labour.

SCHEDULE OF DAYWORK RATES	
Trade	**Rate per hour**
Foreman	£
Site Supervisor / Working Supervisor	£
Certified Engineer / Approved Electrician	£
Engineer / Fitter / Electrician	£
Technician	£
Apprentice	£
% Addition for non productive overtime	%
ADDITION FOR OVERHEAD & PROFIT FOR MATERIALS USE	
Include for the total hire and running costs of plant in use in dayworks, including fuel, spares, and transport to and from the site, unloading and loading.	%
Include for the total cost of materials for use in dayworks including any associated transport costs.	%
Sub-contractors	%

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4-0 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015

We confirm that we are able to allocate sufficient and adequate resources to perform the duties as assigned to the Contractor under the Construction (Design and Management) Regulations 2015.

We have enclosed evidence which demonstrates our competence to perform the duties as set in Appendix 4 of the Construction (Design and Management) Regulations 2015 Approved Code of Practice.

SCHEDULE OF ENCLOSED DOCUMENTATION
Stage 1, Organisation and Arrangements for Health & Safety Management: -
Stage 2, Experience and Track Record : -

5-0 SCHEDULE OF ADDENDUMS

During the course of preparing our tender for the Works details in this Tender Analysis and described in the Associated Specification and drawings, the following Addendums were issued by the Engineer.

We hereby agree that all costs have been included in our tender for the items detailed in the Addendums, including any costs associated with Sections 1 and 2 of this Specification.

SCHEDULE OF ADDENDUMS	
Addendum Number	Date Issued

6-0 SCHEDULE OF WORK TO BE SUB-LET

The Tenderer shall indicate below the names of all Firms for which he proposes to sub-let any part of the works.

SCHEDULE OF WORKS TO BE SUB LET	
Work to Be Sub-let	Name of Sub Contractor

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7-0 TENDER SUMMARY

We, the undersigned, do hereby offer to carry out the whole of the work described in this Specification, and the associated drawings for the project as referenced above, in strict accordance with the terms and conditions thereof, for the following sums of money: -

TENDER SUMMARY		
Item	Description	Total Cost
1	Project Tender Costs	£
2	Provisional Sums	£
	Total Fixed Price	**£**
	State any inclusion for Main Contractors Discount (MCD)	**£**
	Total	**£**

ACTIONS	
Complete?*	Description
YES / NO	Schedule of Day Work Rates COMPLETED?
YES / NO	CDM - Evidence of Competence ENCLOSED?
YES / NO	Material Schedule COMPLETED?
YES / NO	Schedule of Alternative Materials (refer Clause 1B-5) ENCLOSED?
YES / NO	Schedule of Addendums COMPLETED and INCLUDED?
YES / NO	Schedule of Work to be Sub-Let COMPLETED?
YES / NO	Lift Appendix 1 – deviation from specification requirement ENCLOSED?
YES / NO	Lift Appendix vi – Compliance Schedule COMPLETED and ENCLOSED?

** Delete as necessary*

TO BE COMPLETED AT TIME OF TENDER	
FIRM	
ADDRESS	
SIGNED	
DATE	

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