Birstall Community Hall

Building Services Performance Specification

Issue 2

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T1	12/12/17	Tender Issue	WJ/DH	MM
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1.0 CONTRACT PRELIMINARIES

1.1 Main Contract Preliminaries

The Mechanical and Electrical Contractor shall observe, perform and comply with all the provisions of the Main Contract preliminaries.

If anything within the M&E contract documents conflicts with the main contract or any other documents, the M&E contractors shall allow for the most onerous and highlight the issue to the Main Contractor in good time, so an instruction can be given on how to proceed.

1.2 The Project

The project involves the provision of a new single storey community centre in Birstall, Leicester.

This performance specification relates to the Mechanical and Electrical (M&E) services which are to be provided to the development.

1.3 Definitions and Parties Involved

The following definitions shall apply unless there is something in the subject or context inconsistent with such.

For the purposes of this document The Employer shall mean:
(referred to in this document as The Employer)

Birstall Parish Council
Council Offices
Birstall Road
Birstall
Leicester
LE4 4DH

0116 267 6191

admin@birstallpc.org.uk

The Project Manager shall mean:
(referred to in this document as The Project Manager)

Chesterton Smart
28 Highfield Rd
Groby
Leicestershire
LE6 OGU

Tel: 0116 224 3156

The Main Contractor shall mean:
(referred to in this document as The Main Contractor)

TBC

The Architect shall mean:
(referred to in this document as The Architect)

TBC

The Engineer shall mean:
(referred to in this document as The Engineer, The Consultant, or the Services Consultant)

Built Environment Consulting
5 Redwing Court
Castle Donington
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DE74 2UH

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The Mechanical and Electrical Contractors shall mean:
(referred to in this document as, the M&E Contractors, or The Mechanical Contractor, or The Electrical Contractor)
The Contractor/s appointed to execute the works, which are subject to the contract, and shall include the Contractors Personal Representative, Successors, sub-contractors, and Assignees.

1.4 **Interpretation of Wording**

Where clauses in the Mechanical & Electrical Specification refer to information to be provided to the Main Contractor by the M&E Contractors, that clause shall mean that information is to be provided to the Project Manager by the Main Contractor.

Where clauses in the Mechanical & Electrical Specification refer to comment by the Main Contractor that clause shall mean that comments are to be made by the Project Manager to the Main Contractor, which shall be passed to the M&E Contractors by the Main Contractor for his action.

Where clauses in the Mechanical & Electrical Specification refer to approval of or to the satisfaction of the Main Contractor that clause shall mean that approval is to be sought and given, by the Project Manager to the Main Contractor.

Where the services documents refer to 'provide' this shall mean design, procure, install, test, commission, put to work, and fully demonstrate the operation to the client at PC, and anything else that can be reasonably inferred as necessary to provide fully operational and functional systems.

1.5 **Scope of Works**

The mechanical and electrical installation works shall be procured using a design and build procurement route with the D&B sub-contractors in full compliance with the specification documentation and the information referred to therein. The M&E Contractors shall be responsible for the whole of the design process including the verification of early stage design information provided by the Building Services Consulting Engineer.

The whole of the mechanical services installation works shall be carried out by a Mechanical Contractor whom is a registered and approved member of the Heating

and Ventilation Services Contractors Association (HVCA) and Gas Safe Registered as appropriate.

The whole of the electrical services installation works shall be carried out by an Electrical Contractor whom is a registered and approved member of the NICEIC and is also a member of the ECA.

The scope of the project shall include the design, supply, delivery, installation, testing, commissioning and maintaining during the first year after handover, of the entire mechanical and electrical installations as set out below, as detailed in all sections of the contract documents, and as shown on the contract drawings.

The scope of the design input shall include the verification and subsequent design development of the design proposals provided. This shall include the provision of all drawings, calculations, and other documentation as set out in this document.

The Contractor/s appointed to execute and provide the Technical Design works, which are subject to the contract, and shall include the Contractors Personal Representative, Successors, sub-contractors, and Assignees.

The Mechanical and Electrical Contractors shall note that the drawings and specifications provided as part of this enquiry document may not show or refer to every component, system or solution that is required to meet the performance requirements or design intent set out in the enquiry. It is the Mechanical and Electrical Contractor's responsibility to ensure that due allowance is made at tender stage for all costs associated with meeting the requirements of the enquiry whether or not shown on the drawings. Where necessary the cost of these items may be separately shown in the pricing schedules or otherwise included in other items in the pricing schedules.

The Mechanical and Electrical Contractors must take full account and be fully compliant with all contract documents.

In areas where drawings or specification have omitted some services which may be required to meet the performance levels within the document listed above, it will be assumed that all associated costs with their delivery have been allowed at this stage – these should be separately highlighted in the tender submission.

1.6 **Attendance Provided on Sub-Contractors By The Main Contractor**

The Subcontractor shall be fully responsible to provide all resources and attendance to design and provide the works.

1.7 **Programme and Phasing**

The Mechanical and Electrical Contractors programme of works shall be in accordance with main contractor's programme. In particular, the Subcontract and the dates therein including any sectional completion dates referred to within the documentation.

The Mechanical and Electrical Contractors shall be aware that the project may be constructed in a number of phases. They shall therefore make themselves fully aware of the main contractors phasing program during the tender period.

1.8 **Design Responsibility, Design Development and Coordination**

1.8.1 **General Requirements**

Whilst the project design concepts have been provided by the design team generally, it shall be the Mechanical and Electrical Contractors responsibility to design, supply, install, test and commission all mechanical, electrical and public health services in their entirety.

This shall include the provision of a full set of "**Construction and setting out drawings**" demonstrating that the design has been developed and that full coordination has taken place.

The aim of the design solution is to provide a low energy building services solution.

During the Building Regulation compliance review process, the Mechanical and Electrical Contractors will advise the Main Contractor of any specialist requirements for the building over and above those already specified.

The Mechanical and Electrical Sub-Contractor shall include for the design development of the scheme indicated on the tender information through to completed installation. This shall include all design development costs, and associated installations costs, including the supply, erection, fixing, connecting, setting to work, testing commissioning and maintaining in accordance with the manufacturers recommendations of the entire works as described in this specification, on the tender drawings and as may be reasonably inferred as necessary.

The Main Contractor shall note that it is a recommendation of this specification document that the mechanical and electrical installations are procured using a single M&E Contractor who is responsible for the whole of the mechanical and electrical installations.

Should a single M&E Contractor not be used then the M&E Contractors shall be jointly responsible for coordination and for providing a set of combined fully coordinated drawings and details, including sections of key pinch points etc.

The tender issue of mechanical and electrical information shows "design intent" only and have been subject to limited first order coordination. The M&E Contractors shall therefore be responsible for developing the design intent proposals indicated on the tender drawings and providing within his tender, a fully developed and coordinated installation proposal. The M&E Contractors should make all necessary allowance for this coordination including, where necessary, the re-routing of services or the setting up and down of services etc.

Once the M&E Contractors have been appointed, and have begun the development of their design and installation drawings, no further drawings shall be issued by the Employer team. This is to ensure that only one set of design drawings are in circulation at any time and therefore remove any risk of ambiguity or confusion. For clarity, the contractor as the designer, shall take full responsibility for his design and make due allowance for design development and redesign as necessary to achieve sign off to construction issue 'status A' incorporation all comments received the Employer, Project Manager, and M&E Consultant.

Information provided by the design team post tender to communicate changes in requirements will be in various forms. This may include hand marked up drawings, sketches, extracts of drawings, schedules, faxes, emails and the like at the discretion of

the design team. The M&E Contractors shall be responsible for incorporating this information into his installation proposals information in a timely and speedy manner.

The Building Services Design Consultant shall be retained by the Main Contractor to undertake a review and audit role covering the information and installation works provided by the M&E Contractors to fulfil the requirements of the specification and contract drawings.

The M&E Contractors shall note that the checking by the Building Services Consultant does not relieve the M&E Contractors of any responsibilities under the contract.

The responsibility for the design of mechanical and electrical services installation shall remain with the M&E Contractors.

This contract shall include for both the installation works and the preparation of all drawings and calculations.

The M&E Contractors shall allow for the timely submission of all drawings, calculations, and schedules to the Employer Representative, such that preparation of subsequent issues of co-ordinated working drawings including any Employer Representative comments shall be carried out in sufficient time to allow progress to the agreed contract programme.

The M&E Contractors shall allow for the issue of working drawings, placing all necessary orders, delivery to site, off-loading and erection of all materials and equipment, all labour for installation, supervision and inspection, specialist labour and all necessary instruments and attendance for testing and commissioning, provision of operating and maintenance instructions and record drawings, supply of special tools, training of the Employer's staff; in accordance with the details outlined in this specification and associated drawings to achieve completely functioning systems, fully adjusted, and ready for use.

The M&E Contractors shall provide mechanical and electrical services installation that is compliant with current Building Regulations including planning requirements. The M&E Contractors shall include for all necessary meetings, attendances, calculations (where applicable), drawings and submissions to achieve Building Regulations approval. The M&E Contractors shall include for liaising with Building Control and members of the design team in pursuit of Building Regulations approval.

1.8.2 **Format of Drawings and Calculations**

Drawings shall be issued by the contractor in pdf, and hard copy both A3 and full size. Drawings shall be issued in AutoCAD dwg format as requested.

Calculations shall be undertaken using propitiatory building services design software such as Amtech, Hevacomp, IES, Cymap, TAS, Dialux, and Amtech. All software packages shall be CIBSE accredited. The contractor shall issue pdf and hard copy of all inputs, calculations, and output reports.

The contractor shall issue the software model and calculation files as requested.

1.8.3 **Position of Plant, equipment, and outlets**

The routes of all distribution, and positions of plant, equipment, and outlets, as shown on the drawings are given for tendering purposes only. No claims will be entertained for variations in positions.

1.8.4 **Co-ordination**

The M&E Contractors shall allow for liaising with the Main Contractor and others as necessary to ensure co-ordination of the work with related building elements and services and correct positioning of equipment.

The M&E Contractors shall provide three sets of co-ordination/installation/working drawings and other information detailing the following services;

- Specific builders work requirements including sizes and locations of all holes and openings.
- Identify access required for future maintenance.
- The complete mechanical and electrical installation.
- Other information as may be required by the Main Contractor together with equipment manufacturer's working drawings and wiring diagrams of all equipment being provided by the M&E Contractors as part of this contract.
- The M&E Contractors shall make any necessary amendments to accord with the Main Contractor's comments and re-submit.
- Provide sufficient copies of the final versions of the drawings/information, including 3 copies for the Main Contractor and distribute them to all interested parties.
- The tendered should make all due allowances for the necessary attendance at co-ordination meetings as directed by the Main Contractor.
- The M&E Contractors shall ensure that in fixing the work in this contract it will not obstruct the fixing or future maintenance of adjacent services. The M&E Contractors shall also fully co-operate with the Main Contractor and all other Sub - Contractors and take all reasonable precautions to ensure that his progress does not impede the progress of their work
- The M&E Contractors must take all precautions necessary to restrict the area of his work to the immediate vicinity of the work involved in this contract
- All of the implications of these restrictions and methods, which are to be adopted, must be fully considered and allowances for them made in the tender price
- By way of confirming the design to the Main Contractor the M&E Contractors shall provide co-ordinated installation drawings and design calculations (where appropriate) to support and illustrate the development of the design indicated in the relevant specification and drawings
- The M&E Contractors shall be responsible for ensuring the co-ordination of their installations within the building structure and with known zones and routing of other M&E Contractors installations identified on the drawings and at meetings. He shall attend co-ordination meetings to be held weekly or more often as necessary on site chaired by the Main Contractor and with other Sub - Contractors in attendance

- The M&E Contractors shall request from other Sub - Contractors deemed necessary to carry out his co-ordination function. The Main Contractor shall confirm the status of relevant installation package information and issue appropriate information

- Lack of knowledge with respect to other work packages shall not be considered and the M&E Contractors shall carefully examine all information available

1.8.5 **Documents to be Provided by the M&E Contractors**

Documents shall be provided to a programme developed and agreed with the Main Contractor, for the purposes of tender the following shall be used. The Services Contractor shall make allowance in their programme for comments made by the Main Contractor.

1.8.5.1 **Prior to Release of Successful Contractors Order**

Quantified and reconciled Schedule of Rates for all M&E

Procurement Schedule, cross refenced with design programme and installation programme.

1.8.5.2 **Prior to Attendance at the Pre-Contract Meeting**

A full list of proposed Mechanical, Electrical and Public Health drawings to be issued during the programme. This shall include proposed dates of issue of all drawing types led by co-ordination and builders-work drawings.

An M&E project programme including first and second fix dates for M&E sub-trades, plant lift dates, commissioning periods, and key information such as plant procurement lead in periods.

1.8.5.3 **10 weeks before Installations Commencement**

- Detailed design calculations where required.

1.8.5.4 **6 Weeks before Installation Commencement**

- Co-ordinated M&E working drawings for comment. (Installation / Working Drawings detailing all aspects of the M&E Contractors Proposals).

- Builders work drawings or earlier as required by the Main Contractor.

- M&E programme of works showing the co-ordination with other building activities.

- Information to support a Building Regulations application.

- Comprehensive schedule of mechanical and electrical installation components and equipment.

1.8.5.5 **During Installation**

- Progress chart, based on programme, updated weekly to include progress achieved and programme variations.

- Complete set of drawings marked "As Installed Site Copy", on which all revised installation details shall be recorded as they occur.

- Documentary evidence of Building Regulations Approval.

1.8.6 **Production Information:**

The M&E Contractors must:

- Liaise with the Main Contractor and others as necessary to help ensure co-ordination of the work with related building elements and services.

- Provide details and other information as specified showing such details of works as the Main Contractor may reasonably require.

- Submit to the Main Contractor for comment, make any necessary amendments and resubmit for further comment unless the Main Contractor confirms that this is not necessary.

- Submit sufficient copies of final information to the Main Contractor for distribution to the M&E Contractors and all affected parties.

The drawn and other Information to be provided must include, but not limited to;

- Co-ordination drawings
- Calculations
- Detailed schematic drawings
- Builders work information
- Installation drawings
- Controls drawings
- As installed drawings
- Record drawings
- Operating and Maintenance Manuals
- Building Log Book
- Part L2 Building Log Book

The Drawn and Other Information must comply with standards agreed in advance with the Main Contractor in respect of scale and drawing size.

Builder's Work Information: It is the M&E Contractors responsibility to confirm information provided to the Main Contractor.

Plant Room Schedules and Schematics: The Services Contractor shall frame the following under glass and hang in each plant room and any other appropriate location;

- Location of main incoming gas valve serving gas meter.
- Emergency operating procedures and telephone numbers of emergency call out service applicable to any system or item of plant and equipment.
- Technical Literature: The M&E Contractors are required to keep copies of the following on site, readily accessible for reference to all supervisory personnel:
- Manufacturers' current literature relating to all products to be used in the Works

1.8.7 **M&E Contractors Drawings and Calculations Submission**

The M&E Contractors are required to submit all installation / working / co-ordination drawings and calculations to the Employer's Representative for review in terms of technical feasibility and spatial relationship.

Drawings shall be assessed using an A / B / C drawing status system. The Employers Representative's comments shall not constitute any form of "approval", and they shall not necessarily be exhaustive.

Rejection of the drawings for reasonable technical shortcomings or lack of spatial co-ordination shall be binding, however. Comments shall be made in the following format:

Status "A" No Comment

Status "B" The M&E Contractors may proceed subject to incorporating the comments as set out.

Status "C" The M&E Contractors shall re-submit the drawing before proceeding further, incorporating comments.

Drawings comment shall be issued as two hard copy (not electronic format) drawings to the Employer's Representatives (M&E consultant and Architect) for review, with a single copy to the Quantity Surveyor and the Project Manager.

A single copy of each of the latest set of M&E Contractors drawings shall be issued to the Employer for Review on demand.

Drawings submissions should be provided by the M&E Contractors to allow at least two weeks (10 working days) for the Employer's Representative to return comment. The M&E Contractors shall obtain a record of receipt from the Employer's Representative within three days of any drawing issue. Should comment not be forthcoming after two weeks, the M&E Contractors shall further communicate with the Employer's Representative to record the consequences of any lack of comment.

Lack of comment shall in no circumstance confer any acceptance or approval of the M&E Contractors proposal. Please note that a significant M&E services issue drawing and calculation issue to the consultant shall require more than the 10 days turnaround.

It shall be noted that any installation proposal drawings shall not be given a status higher than status "C" if not accompanied by a multi-service co-ordination drawing that demonstrates that correct clearances and tolerances have been designed between all services, adequate commissioning and maintenance access has been detailed, and correct clearances have been provided between the services and the structure.

Any installation works carried out on proposed installations designated status "C" or unchecked by the Employer's representative, shall be at the M&E Contractors own risk and any claim for delays or recompense should the works be found to be defective or inadequate shall not be considered.

The Mechanical Contractor shall submit to the Engineer for inspection and comment prior to installation, and in sufficient time as not to cause delay to the contract, his design and working drawings to the requirements laid down in section 2 of this Specification which shall include all builders work. Drawings should be complete with all associated calculations and shall be fully co-ordinated with the structure and other services.

Failure to comply with this clause shall mean all works carried out will be solely at the risk of the Mechanical Contractor and any rectification work deemed necessary shall be carried out entirely at the expense of the Mechanical Contractor to the satisfaction of the Engineer.

No works will be authorised to proceed until the design and drawing information has been correctly submitted and approved by the engineer.

1.8.8 **Summary of General Building Services Scope**

The scope of the mechanical and electrical services installation shall include, but not be limited to, the following: -

- Design development and coordination of the M&E Services
- Provision of dimensioned and Setting Out drawings
- Preparation of method statements, and construction phase health and safety plan.
- Mechanical and Electrical services as required meeting Building regulations and the requirements of this specification.
- Provision of Labelling and Charts
- Testing and Commissioning
- Operating and Maintenance Manuals
- Building Log Book
- Operating and maintenance manuals
- Demonstration of commissioning and operation of plant and systems
- Any other item mentioned in this specification or as reasonably inferred as necessary.

The Mechanical and Electrical Contractors shall adopt the design principles embodied in the specification documentation and shall be responsible for the development of the design of the mechanical and electrical services in accordance with the required set out.

1.9 **Dimensions and Setting Out**

Any dimensions provided on the tender drawings or within the specification are for indication only.

It may be a requirement of the main contractor that room elevations are provided to assist in the "setting out" of equipment. The Mechanical and Electrical Contractor shall allow for providing all such elevations as can reasonably be expected.

It shall be the Mechanical and Electrical Contractors' responsibility to assist the main contractor in the development of this information, and provide any information the main contractor deems as required to allow them to complete the element of work.

1.10 **Builders Work**

It shall be the service contractors' responsibility to provide a full set of builder's work drawings, showing all required dimensions and setting out.

The Mechanical and Electrical Contractor shall make due reference to all available information when providing builders work information to ensure that the dimensions are as accurate as possible, this information may include, but not be restricted to:

- Tender building services drawings.
- Architectural drawings.
- Architectural "indicative" furniture layout drawings.
- Specialist furniture supplier's drawings.
- Furniture and equipment planning drawings.
- Etc.

The service contractor shall ensure that all necessary liaison takes place to ensure that locations of all services are fully coordinated.

The Main Contractor shall be responsible for all builders work in connection with the mechanical and electrical services installation work above holes of 50mm ø. Holes up to 50 mm ø shall be provided by the M&E Contractors in liaison with the Main Contractor.

Builder's work by the Main Contractor shall not include drilling and fixings for brackets etc. which will remain the responsibility of the M&E Contractors.

The M&E Contractors will be responsible for identifying and marking out of all builders work. He shall produce any necessary drawings detailing builders work requirements for submission to the Main Contractor as previously stated.

1.11 **Building Services Systems Supply, Installation and Management To Be Provided**

The tender set of mechanical and electrical installation design drawings have been subject to first order coordination only.

The Mechanical and Electrical Contractor shall therefore be responsible for developing the proposals indicated on the tender drawings and providing within his tender, a fully developed and coordinated installation proposal. The Mechanical and Electrical Contractor should make all necessary allowance for this coordination including, where necessary, the rerouting of services or the setting up and down of services etc.

Information provided by the design team post tender to communicate changes in requirements will be in various forms. This may include hand marked up drawings, sketches, extracts of drawings, schedules, faxes, emails and the like at the discretion of the design team. The Mechanical and Electrical Contractor shall be responsible for incorporating this information into his installation proposals information in a timely and speedy manner.

The Mechanical and Electrical Contractor shall note that changes in requirements will not in the majority of cases be communicated using electronically prepared drawings.

The Mechanical and Electrical Contractor shall note that the checking by the Building Services Consultant does not relieve the Mechanical and Electrical Contractor of any responsibilities under the contract.

The Mechanical and Electrical Contractor shall undertake the contract in a spirit of partnership i.e. in a cooperative non-confrontational manner.

The Mechanical and Electrical Contractor shall cover the preparation of all drawings, including detailed builders work, all necessary schedules, and submission of all drawings.

The Mechanical and Electrical Contractors detailing obligations shall include but not be limited to the following: -

- Fabrication drawings and the co-ordinated Installation/Working Drawings and Record Drawings.
- Drain points shall be inserted at all low level positions and vent points at all high level locations, with Auto Air Vents and bottles where ever possible.
- Pipework gradients in accordance with BSRIA documents Application Guide 1/89 Flushing and cleaning of Water Systems.
- Bracket and support detailed design and locations. (All types, loads and locations must be declared to the Contract Administrator prior to installation for comment (10 working days). Particular reference is drawn to roof/purlin loads as indicated on the Structural Engineers drawings
- Details of Electrical wiring diagrams of all equipment supplied by the Mechanical and Electrical Contractor showing all interconnections between equipment to enable the necessary wiring to be undertaken.
- Details of all equipment component design and selection necessary insofar as such items have been selected by the Mechanical and Electrical Contractor for that item of equipment to meet the engineering specification and performance indicated.
- Positioning of plant shall include identified maintenance space and indicated upon as fitted drawings.

Dimensioning of, and final installation details of, the Automatic Control panels to suit the detailed requirement of the particular agreed manufacturers of controls equipment and cable entry/exit accommodation such that:

- Cable entry is possible in the selected location.
- Doors are not fouled by other plant, equipment, services or structural elements.
- Safe operating and maintenance clearances are provided in all access positions when installed on site.
- Fire alarm system, component and cabling requirements to meet with particular manufacturer's and the engineering specification's requirements.
- Attenuator design and selection to satisfy the particular and performance requirements of the specification, including spatial allowances made within tender drawings.
- Design of elements of the scheme provided by the Mechanical and Electrical Contractor for self-weight and other applied forces/loadings in reasonable use. In particular, any buried tanks or pipework will require designed anchorage encasement or foundations.
- Submit calculations and proposals to demonstrate the design has fully considered the requirements for thermal expansion accommodation and anchorage, including provision of bellows or bends.
- Acoustic design or modification of equipment to meet with the noise levels specified. All levels to be achieved with all M&E operating plant
- Valve, damper and access locations.
- System water capacities, and chemical additives - and arranging of the facilities required by BSRIA Application Guide 8/91 pre-commission cleaning of water system
- Selection of all anti-vibration mountings to suit the particular application of the mounts.
- Final exact locations of control sensors detectors and thermostats.
- Capacity, location and design of electrical conduit system, similarly trunking where used in lieu of multi-conduit installation.

- Duct platforms, access covers and gratings, ladders and additional structural steelwork where required and detailed in the sub-contract documentation.
- Selection of regulation devices to comply with CIBSE Technical Memorandum TM8.
- Sizing of cable terminations on items of equipment provided under the sub-Contract where cable sizes are specified.
- Ensuring cable sizing selections as specified are not invalidated by Sub - Contractor selection of alternative routes during installation.
- Detailed design of earthing and bonding requirements for electrical engineering services, mechanical engineering services, architectural and structural elements requiring earthing and bonding.

Design of cable or cable trunking terminations on to electrical equipment provided under the sub-contract and dimensioning of and final installation details of electrical switchgear to ensure that:

- Cable entry is possible in the selected location.
- Fuse sizes installed in plug tops are appropriate for the rating of connected equipment.
- Sizing and detailed design of refrigerant pipework between items of equipment provided under contract works.
- Detailed coordination and planning of services within Service Risers including provision of plan, section and elevation drawings.
- Programming and co-ordination of installation activities to minimise disruption and inconvenience to the site.

1.12 **Design Criteria**

Contractors design shall comply with the following as a minimum:

- The planning permission and all associated conditions
- Building Regulations and all current amendments as at the date of tender return
- The Construction (Design and Management) Regulations 2015 and all current amendments as at the date of tender return
- The Health and Safety at Work Act 1974 including all relevant amendments and enactments current as at the date of tender return
- The Fire Precautions Act 1971 including all relevant amendments and enactments current as at the date of tender return
- Requirements of the Local Environmental Health Officer
- The Equality Act 2010
- Control of Asbestos Regulations 2012
- All relevant British Standards and Approved Codes of Practice in relation to the works
- CIBSE Guides, Codes of Practice and Knowledge Series Information
- Water Fittings Regulations
- Regulations imposed by local Water and Electrical Undertakings
- BS: 7671 - Requirements for electrical installations. IEE Wiring Regulations. Seventeenth edition
- BS 5266 Parts 1-10 and BS EN 50172 – Code of Practice for Emergency Lighting
- BS 5839 Parts 1-11 and PD6531:2010 – Fire Detection and Alarm Systems for Buildings
- The Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations 2007
- Current British Standard Specification and Codes of Practice
- Conservation of Fuel and Power Part L2, 2010 Edition, DCLG

- Chartered Institution of Building Service Engineers Guides and Commissioning Guides
- BSRIA Commissioning guides
- EEC Legislation
- Current Building Regulations
- British and EEC Acts of Parliament
- Standards and Guidelines including current practice, published by HVCA
- Ductwork Standard (HVCA) DW144
- Water Supply (Water Fittings) Regulations 2010
- Current Gas Safety Regulations
- Institute of Gas Engineers UP/1 and 2
- HSE ACOP L8 Legionella Disease
- Gas Register Recommendations
- Manufacturer's Recommendations
- Environmental Protection Act
- The Employers Requirements including all supporting documentation.

Where there is conflict between any standard the Mechanical and Electrical Contractor shall bring it to the attention of the Main Contractor and the CA. The most onerous version/interpretation shall apply prior to any decision or interpretation by the Main Contractor.

1.13 **Public Utilities Authorities**

BEC Consulting have made the appropriate applications to the statutory authorities for the provision of the incoming services.

Once the Main Contractor has been appointed, it shall be their responsibility, together with the Mechanical and Electrical Contractor, to adopt the application process to ensure that the incoming services are provided to their requirements.

The Mechanical and Electrical Contractor shall allow for co-operating with and working in conjunction with the public bodies/utility suppliers and integrating their works within his programme.

The Mechanical and Electrical Contractor shall ensure that the public bodies/utilities suppliers and their Agents are fully aware of the programme requirements relating to their work and any changes to these programme requirements. The Mechanical and Electrical Contractor shall immediately make the Main Contractor aware of any matters relating to the works being carried out by the public bodies/utility suppliers which may affect the works of the programme.

The Mechanical and Electrical Contractor shall afford facilities to properly accredited representatives of public bodies/utility suppliers for access to any existing apparatus as may be necessary for inspecting, maintaining, removing, diverting, renewing or any other purpose.

The Mechanical and Electrical Contractor shall include for the all charges made by any Authority approving any relevant part of the works.

1.14 **Thermal Model, SBEM and EPC**

The Mechanical Contractor shall allow for as part of their design to undertake their own SBEM compliance checks, and take full and ultimate responsibility for compliance.

It shall be the responsibility of the Mechanical Contractor to liaise with the Electrical Contractor to ensure that the thermal model is reflective of the design.

Should there be a value engineering exercise and the Mechanical and Electrical Contractor wish to propose alternative products, then these revised details need to be inputted into the thermal model to ensure that the Thermal Model remain updated and achieved compliance.

It is strongly recommended therefore that should any material changes be considered that an allowance be made for the re-running of the Thermal Model as part of the evaluation exercise.

The Mechanical Contractor shall also allow for providing the as built SBEM and EPC prior to completion.

1.15 **Building Regulations Compliance Review**

The Mechanical and Electrical Contractor shall be responsible for installing, commissioning and setting to work the M&E systems in order to comply with the requirements of Approved Building Regulations Document Part L2A

The Mechanical Contractors appointed Specialist will be responsible for the production of all calculations and documentation required to prove compliance with the Building Regulations approved Part L2A document. This will be in the form of proving that the building emission rating is equal or better than the target emission rating and how this is achieved.

1.16 **Information Provided for Tender Purposes**

The Mechanical and Electrical Contractor shall utilise all the information in the preparation of his tender.

No claims for lack of information shall be entertained unless the Mechanical and Electrical Contractor have formally advised the CA/PM or Clients representative of the lack of any of the information listed above.

1.17 **Attendance Provided On Sub-Contractors by Main Contractor**

All attendances provided to the Mechanical and Electrical Contractors by the Main Contractor are to be confirmed by the Main Contractor including all coordination and integration into the main contract works. The Mechanical and Electrical Contractor is to ensure that they query / clarify all aspects of any attendance provided by the Main Contractor during the tender period and includes any costs.

This shall include programming procedures to comply with commissioning programmes and networks.

1.18 **Site Visit**

Prior to submission of his tender the Mechanical and Electrical Contractor is advised to visit site to ascertain the works involved. No claim for lack of site knowledge in connection with this work will be considered.

1.19 **List of Proposed Suppliers and Manufacturers**

Tender submissions must be in compliance with the Mechanical and Electrical Services documents.

The tender must be based on equipment and plant as indicated in the specification, schedules and drawings with preference given to suppliers listed on the Governments Enhanced Capital Allowances (ECA) approved schedule.

Where products, equipment and plant etc. are uniquely specified as part of the tender package the Mechanical and Electrical Contractors shall allow for including them in their tender return.

Alternative design proposals, suppliers or specialists will only be considered if submitted in accordance with the Building Services documents, or as otherwise agreed.
Any items of non-compliance must be advised and agreed on the return of the tender or before award of the contract. Non-compliant items after the contract award will not be accepted.

Equal and approved suppliers will be considered where so stated in the tender information, provided that they are equal to or better in terms of performance and quality to that specified. Where equal and approved is not stated the Mechanical and Electrical Contractor must use the named supplier / products.

The Mechanical and Electrical Contractor shall provide all comparable figures extracted from published literature to allow the Clients representatives to make a full and thorough assessment of the proposals being made.

The Mechanical and Electrical Contractor shall be responsible for assessing and reporting any implications on material and product changes in terms of Building Regulations, Planning, and any other relevant party or parties.

Should calculations be required, for items such as lighting, then it shall be the Mechanical and Electrical Contractors responsibility to obtain all such calculations prior to any approval of the proposed alternatives.

Samples of all proposed alternatives shall be made available to the design team prior to any approval of alternatives being granted.

The Client or Client representatives shall retain the right to reject any or all of the alternatives and any such products, plant and equipment installed without approval shall be removed and replaced at the discretion of the Client or their representative, and at the Mechanical and Electrical Contractor's cost.

The Mechanical and Electrical Contractor shall not install plant or equipment from suppliers or manufacturers that require exclusive or onerous maintenance agreements, unless such items are herein specified or the Client has given permission for such in writing.

The Mechanical and Electrical Contractor shall allow to provide samples of all M&E equipment where reasonable and shall seek formal sign off by the Architect, Main Contractor, Consulting Engineer and Client prior to procurement.

If any alternative Manufacturer is included within the Mechanical and Electrical Contractors Tender Return as an optional cost saving, the Mechanical and Electrical Contractor must make due allowance for the design and provision of for example the

alternative plant room ductwork, pipework, cables and wiring etc. schemes and ancillary equipment as necessary to accept the alternative equipment.

The Mechanical and Electrical Contractor shall provide full calculations to demonstrate that the alternative equipment satisfies the design conditions; and provide documentary evidence such as materials controls and certificates, to demonstrate that the equipment is equal to that specified.

The Mechanical and Electrical Contractor shall include for the effect of any changes in materials, such as the updating of the Thermal Model, in their cost comparison.

All plant must comply with the Non-Domestic, Heating, Cooling and Ventilation Compliance Guide as detailed within the approved Building Regulations.

1.20 **Operation and Maintenance Manuals**

The Mechanical and Electrical Contractors shall include for the provision of operation and maintenance manual information in accordance with the following clauses. This may be prepared by a specialist at the discretion and expense of the Mechanical and Electrical Contractor, however, before instructing any such specialist the Mechanical and Electrical Contractor must seek approval of the Main Contractor for the specialist proposed.

Allow not less than three working weeks for the approval period and under no circumstances proceed with instruction without written approval.

The operating and maintenance manuals shall include:

- A full technical description of each of the systems installed, written to ensure that the Employers staff fully understand the scope and facilities provided and logic of control.
- A technical description of the mode of operation of all systems, and a copy provided on a CD-Rom or DVD in an easily navigable, indexed and searchable Adobe PDF format.
- Diagrammatic and schematic drawings of each system indicating principle items of equipment, together with design flow rate and load information.
- A photo-reduction of all record drawings to A3 size, together with an index.
- All record drawings shall be provided in both latest AutoCAD format and Adobe PDF format and be presented on CD-Rom or DVD, they shall be clearly marked as a 'Record Drawing'.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list numbers.
- Selection data for each item, such as pump duties.
- Manufacturer's technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant material and including detailed drawings, and operating and maintenance instructions.
- A copy of all Test and Commissioning sheets and Certificates of Completion. These shall include a statement of what guide the test was undertaken.
- A copy of all manufacturers' guarantees or warranties. These two should be separate sections.
- Detailed recommendations as to the preventative maintenance frequency and procedures which should be adopted by the Employer to ensure the most efficient operation of the systems.
- A list of normal consumable items.

- A list of recommended spares to keep in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacement is required at some future date.
- Procedure for fault finding.
- Risk assessments and H&S information covering materials/chemicals installed as part of these works.
- Emergency procedure, including telephone numbers for emergency services.

1.21 **Requirements In The Absence Of Manuals**

In the event of the Operation and Maintenance Manuals and/or Record Drawings not being available to the Employer in their final, approved form at handover the M&E Contractors will be required to provide a full time representative whom will be based on site until such a time as all copies of the O&M Manuals and Record Drawings are handed over to the Employer. The representative must be a qualified tradesmen/engineer with sufficient knowledge and experience to maintain the operation of the entire installation in a safe and efficient manner.

1.22 **Building Log Book**

The Mechanical and Electrical Contractor shall provide a building log book in accordance with Part L2 of the Building Regulations, GIL 65 – Energy Efficiency Best Practice Programme and Action Energy GPG 348. It should give details to the owner/occupier with details of all building services within the building, the mode of operation, maintenance, estimated energy consumption and the metering strategy.

The Mechanical and Electrical Contractor shall use the CIBSE Guide TM31 (large building log book) as the template in preparing the building services log book.

1.23 **Snagging and Witness Testing**

The Client and/or Client's Representative shall snag and witness test the building services installation at regular intervals.

A formal snagging record shall be issued following each snagging and witness testing visit which shall require a formal response from the Mechanical and Electrical Contractor in terms of either making a comment or confirming that the snag has been completed.

The completion of the snags shall then be confirmed at subsequent site visits.

Should the failure to advise of the above dates entail that services or components need to be removed to allow snagging and witness testing to be undertaken then this shall be undertaken at the cost of Mechanical and Electrical Contractor.

The Mechanical and Electrical Contractor shall give at least two weeks' notice of the above dates.

1.24 **Co-Ordination**

The Mechanical and Electrical Contractor shall be responsible for the provision of fully co-ordinated design information and a fully coordinated completed installation. The Mechanical and Electrical Contractor shall be responsible for the design and installation of each system such that the building ultimately functions as a fully integrated system.

The Mechanical and Electrical Contractor shall liaise with the Main Contractor and others as necessary to ensure co-ordination of the work with related building elements and services and the correct positioning of equipment.

- The Mechanical and Electrical Contractor shall provide co-ordination/installation/working drawings and other information as previously set out. Information shall include;
- Specific builders work requirements including sizes and locations of all holes and openings.
- Identify access required for future maintenance.
- The complete mechanical and electrical installation.
- Other information as may be required by the Main Contractor together with equipment manufacturer's working drawings and wiring diagrams of all equipment being provided by the Mechanical and Electrical Contractor as part of this contract.

The Mechanical and Electrical Contractor shall attend all co-ordination meetings as directed by the Main Contractor.

The Mechanical and Electrical Contractor shall ensure that in fixing the work in this contract it will not obstruct the fixing or future maintenance of adjacent services. The Mechanical and Electrical Contractor shall also fully co-operate with the Main Contractor and all other Sub - Contractors and take all reasonable precautions to ensure that his progress does not impede the progress of their work.

By way of confirming the design to the Main Contractor the Mechanical and Electrical Contractor shall provide co-ordinated installation drawings and design calculations (where appropriate) to support and illustrate the development of the design indicated in the relevant specification and drawings.

The Mechanical and Electrical Contractor shall be responsible for ensuring the co-ordination of installations with the building structure and fabric and within any defined zones, and with other Mechanical and Electrical Contractors installations whether identified on drawings or at meetings.

The Mechanical and Electrical Contractor shall provide all necessary assistance during the design development and coordination stages including completing all necessary changes to the drawings to allow proper co-ordination works to take place.

The Mechanical and Electrical Contractor shall request information from other Sub - Contractors as necessary to carry out his co-ordination duties. The Main Contractor shall confirm the status of other relevant installation package information and shall ensure timely issue of such information.

Lack of knowledge with respect to other work packages shall not be considered acceptable. The Mechanical and Electrical Contractor shall be responsible for seeking out and carefully examining all information available.

1.25 **Concealment**

No work shall be covered up or put out of view without the approval of the Main Contractor. The Mechanical and Electrical Contractor shall afford due notice and full opportunity for the examination, testing, certification and measurement of any work that is about to be covered up or put out of view.

1.26 **Fire Stopping**

Provide proprietary fire stopping where the Building Services pass through a fire compartment.

1.27 **Interference with Other Services**

The Mechanical and Electrical Contractor shall not, without the Main Contractor's permission, interrupt or interfere with the operation of existing gas, water, heating, electrical, drainage and other services. In the case of services owned by the Employer or authorities the permission of the Employer or authority shall be obtained. A permit to work system shall be used which will require the Mechanical and Electrical Contractor to obtain approval for undertaking all works prior to their commencement.

The Mechanical and Electrical Contractor shall be responsible for any damage or loss occasioned by any interruption or interference and shall make good to the satisfaction of the Main Contractor's, Employer or authority as the case may be.

1.28 **Test and Commissioning**

On completion of the installation to the satisfaction of the Main Contractor, the Mechanical and Electrical Contractor shall test and commission the installation in accordance with:

- EFA Building Bulletins
- CIBSE Commissioning Guides/Codes.
- BSRIA Application Guides.
- The HVCA Ductwork specifications.
- The HVCA Ductwork Ventilation specifications
- BS 7671 - IEE 17th Edition Wiring Regulations and Guidance Notes.
- BS 5839 - Fire Detection and Alarm Systems.
- BS EN 62305 - Lightning Protection.
- BS 5266 -Emergency Lighting Systems.
- All other relevant British Standards.
- Equipment Manufacturers Recommendations.

Certificates of tests must be furnished by the Mechanical and Electrical Contractor to the Main Contractor for all plant, equipment or material specified to be tested at maker's works.

The Mechanical and Electrical Contractor shall provide free of charge on the site and at their own and the manufacturers works, such labour, materials, apparatus and instruments as the Main Contractor may consider requisite from time to time and as they may be reasonably demanded to test materials plant, equipment or works as far as completed until the works are accepted as a whole by the Employer.
Commissioning shall include:

- The process of setting a system into its operational state.
- The process of adjusting the system within specified tolerances to obtain the required performance.
- The finalisation and fitting of labelling and circuit schedules.

The Mechanical and Electrical Contractor shall include for attendance during the testing and commissioning of all of the automatic controls systems, and other specialist systems including the fire alarm system.

The Mechanical and Electrical Contractor shall include in his Tender for all costs arising out of carrying out of the aforementioned tests by suitably qualified operatives and including night time visits.

All test certificates are to be made available prior to handover. Handover will be postponed should these certificates not be available.

1.29 **Instruction to Staff**

Before practical completion, explain and demonstrate to the Employers staff the purpose, function and operation of the installations including all items and procedures listed in the Operation and Maintenance File. Include for not less than two operating days for this purpose. The M&E Contractors are to allow for the attendance of any specialist that may be required to fully demonstrate the operation of the system to the satisfaction of the Main Contractor and Employer, e.g. Controls Specialist or specific equipment manufacturers or Commissioning Engineers.

A training programme, detailing who is required to be present for each session, is to be provided by the Services Contractor in good time prior to training being undertaken.

In addition to the Employer training carried out at handover, the M&E Contractors shall allow for two days of re-training and demonstration to staff two months after Practical Completion of the building.

The purpose of this training will be to clearly define and explain to the building users how the building should work and what assumptions have been made (e.g. how the demand controlled ventilation systems works, internal comfort controls, lighting versus daylight etc.)

The M&E Contractors shall also allow for a training day at completion of the project, followed by a second training day 6 weeks later.

1.30 **Tests at Site**

The Mechanical and Electrical Contractor shall carry out such commissioning, pressure, circuit, insulation and other tests and performance and taking over tests on site as may be required by the Main Contractor or his representative, and provide all necessary duly certified instruments, labour and materials required for the purpose of the tests including fuel and power.

In the event of the plant or equipment not passing the tests, all reasonable expenses incurred by the Employer or Main Contractor due to the repetition of such tests shall be deducted from moneys due to the Mechanical and Electrical Contractor.

1.31 **Rejection of Defective Work**

Should the completed works or any portion thereof, before being taken over, be defective or fail to fulfil the requirements of the Conditions of Specification, the Main Contractor shall give the Mechanical and Electrical Contractor notice setting forth particulars of such defects or failure. The Mechanical and Electrical Contractor shall

forthwith make the respective works good, or alter the same to make them comply with the requirement.

Should the defective portion of the Works be required by the Employer for commercial use, he shall be entitled to make use of the same in a proper manner, for a time sufficient to enable him to obtain other plant/equipment to replace it. The Mechanical and Electrical Contractor being allowed a proper sum for the use of the same.

1.32 **Omissions**

The Mechanical and Electrical Contractor shall make due allowance in the tender for any item or items such as trunking and cable tray sets, elbows and bends etc., supports, brackets, flanges, adapters, clips, attenuators, dampers, valves, commissioning sets etc. which although not indicated on the drawings or mentioned in the specification, but which are necessary for the proper construction of the works and the correct operation of the systems in accordance with the best current practice and to comply with the specification.

The Mechanical and Electrical Contractor shall not omit any part of the works described in the specification or shown on the drawings without the written consent of the Main Contractor in writing.

The Main Contractor shall be entitled to instruct the Mechanical and Electrical Contractor to omit any part of the works and the cost of the items omitted shall be deducted from the Contract Price.

1.33 **Training health, safety, welfare and environmental issue**

The M&E Contractors shall comply fully with all statutory safety, health and welfare regulations regarding work people, including those employed by other Sub - Contractors employed on the site and particularly the Safety, Health & Welfare at Work (Construction) Regulations 1995 – SINO. 138 1995, implementing EC Directive 92/57/ECC and provide all relevant details to the Main Contractor to carry out the function of Safety Planning Supervisor for the construction phase of the works.

The M&E Contractors shall comply in all respects with the Factories and Safety in Industry Acts and any other Acts and with any Statutory Instruments or Regulations issued there under.

The M&E Contractors are required to provide a safety method statement clearly indicating the proposed sequence of his works and the precautions he will be taking at each stage in the works to protect his employees, and those of the Main Contractor, other Sub - Contractors, visitors and the Employers personnel and any plant and equipment, etc. Full details of any chemicals or substances proposed to be used in the project construction process should also be detailed fully and the Employer's prior written approval received for its use.

The M&E Contractors shall include for compliance with the Safety, Health and Welfare at Work Acts and Regulations current at the date of tender.

The M&E Contractors shall include for providing all necessary information as required for the Construction Stage to enable the preparation and completion of the Health and Safety File as outlined in the following clauses.

1.34 **Workmanship**

The Engineering Installers, Fitters, Welders employed upon the work shall have received a good training in their trade, shall be of high standard of skill, fully qualified and competent to carry out the work. All welders must have a B.O.C. Certificate or approved equivalent. Where in his opinion any workman is not so qualified the Main Contractor or his representative may request the Mechanical and Electrical Contractor to replace him. The proportion of skilled or unskilled labour employed on the work shall be as approved by National Agreement. All workmanship on the various classes of work throughout the Contract such as installations, welding, fitting, etc., must comply with the generally accepted custom of the particular trades. All workmen must be employees of the Mechanical and Electrical Contractor or fully under the control of the Mechanical and Electrical Contractor unless agreed in writing.

The Mechanical and Electrical Contractor shall have a duty of care to mount system and pipework in a neat and tidy manner; joints in pipework shall be considered in the installation.

1.35 **Ownership of Plant and Materials**

All materials, equipment, plant and apparatus intended for the work and placed on the site shall not be removed (except for the purpose of being used on the works) without the written authority of the Employer or Main Contractor.

1.36 **Suitability of Materials and Products**

Materials and products shall be supplied to suit the temperatures and other conditions to be normally expected to apply after the installation is completed, and also to withstand any test specified herein or in any document referred to herein.

No asbestos based products or CFC products shall be used.

All equipment and materials incorporated in the works shall be new and for the purpose intended.

Samples of materials and products shall be presented to the client and Engineer for approval in good time prior to placing orders. This particularly applies to visible items such as towel rails, heaters and ventilation grilles etc.

Where the tender specification and drawings details specific items of equipment, systems or suppliers these shall be adhered to by the M&E Contractors in terms of quality and performance, with the contractor providing a schedule of prosed equipment and value engineered solutions with his tender,

The Contractor is encouraged to put forward any value engineering proposals for consideration during the tender period. No alternatives will be considered during the design stage.

1.37 **Manufacturers Quotations**

Manufacturers and supplier's quotations have been utilised to assist pre tender cost planning. Where references have been provided within the specification they are for information purposes only. It is the Mechanical and Electrical Contractor's responsibility to verify all quotations to ensure that the scope and quantities described in quotations agree with the specification, drawings and schedules.

The adoption of any quotations shall be at the risk of the Mechanical and Electrical Contractor and any claims for the adoption of quotations shall not be entertained.

1.38 **Protection, Cleaning and Remedial Works**

The Mechanical and Electrical Contractor must suitably cover up and protect where practicable all work carried out and materials provided by him to minimise the risk of damage or contamination such as entry of foreign material during the progress of the works and shall remove such protection as and when directed.

The Mechanical and Electrical Contractor is to take all necessary precaution to avoid damage by his workmen to other work. The cost of such damage, should it occur will be debited to the Mechanical and Electrical Contractor, notwithstanding the precautions taken.

Any damaged work during the Contract period shall be remedied using perfect materials and methods which must be approved by the Main Contractor.

Any defective work, or any work which, in the opinion of the Main Contractor, does not comply with the Specification or drawings shall be rectified by and at the expense of the Mechanical and Electrical Contractor.

1.39 **Removal of Surplus Materials**

On completion of the works and during progress of the works the M&E Contractors shall clear away surplus plant, materials and rubbish and shall leave the site and plant clean, tidy and to the satisfaction of the Architect, Employer or Main Contractor

1.40 **Labels, Schedules and Schematics**

Equipment labels to be engraved thermosetting plastic laminate with 25mm characters, and shall be rectangular incorporating the whole of the plant or title (i.e. DISTRIBUTION PANEL 'A') these are to be secured to the plant items, equipment by appropriate means, with valves shall be identified by numbered disks on suitable chain ensuring that any protective coatings are not damaged. Label and lettering colours shall be agreed by the Main Contractor.

The M&E Contractors shall provide the following items framed under glass and hanging in the relevant plant room or area, appropriate to the current scheme.

Mechanical plant layout drawings, schematic drawings and valve charts.
All other items required under statutory or other regulations.

1.41 **Electricity and water**

The M&E Contractors shall be entitled at his own expense, to use such supplies of electricity and water as are made available on the site for the purpose of the works and shall, at his own expense, provide any apparatus necessary for such use. The M&E Contractors shall be responsible for ensuring that the service and plant is safe for the purpose for which he intends to use it.

1.42 **Dust and Vibration**

The Mechanical and Electrical Contractor shall undertake all work in a manner to ensure that dust, vibration and noise are minimised. All methods of works and the

programme for them are to be agreed with the Main Contractor. Any works which may create high levels of noise, dust and vibration are to be notified to the Main Contractor prior to their commencement so that the client can be advised and put in place the necessary measures to protect sensitive equipment. Any activities not properly co-ordinated will be stopped immediately and the work will have to be reprogrammed. No claims for loss and expense associated with this will be considered and no extension to the contract will be granted.

1.43 **Keys and Special Tools**

Four keys to fit each size of lock shield valve, air lock, stop cock etc. shall be supplied by the Mechanical and Electrical Contractor together with a complete set of spanners, screwdrivers, pliers etc. and any special tools required for the correct maintenance of the installations. Tools shall be handed over to the Main Contractor when the installations are taken over, in a suitable lockable box (where it will be passed to the client at handover).

2.0 ELECTRICAL SERVICES PARTICULAR SPECIFICATION

2.1 Design Responsibility

The Electrical services design is to be undertaken by the D&B Electrical Contractor.

The Electrical Contractor shall be responsible for the detailed design activities listed under the relevant clauses which lists more specific requirements, in addition to those activities normally undertaken through the custom and practice of the industry, all of which are subject to the comments of the Client Representative.

The Electrical Contractor shall warrant that all reasonable skill and care has been taken in the design of the works in so far as the works have been, or will be, designed by him or by specialists employed by him.

The Electrical Contractor shall also take care in the selection of materials and goods to be used in the contract works in so far as the goods are selected by the Electrical Contractor. He shall also give a warranty on the satisfactory performance of any portion of the works for which the work is detailed within the contract by means of performance specification.

The information detailed on the tender drawings and room data sheets shall be interpreted as being an indicative representation of a minimum level provision; the Electrical Contractor shall develop these proposals further to provide a full and complete installation.

2.2 Design Development

The aim of the design solution is to provide a low energy scheme which meets the "briefing documents" without detriment to reliability of service or comfort to the occupants of the building whilst also complying with all relevant legislation.

During the Building Regulation compliance review process the Electrical Contractor will advise the Contractor of any specialist requirements for the building over and above those already specified.

The Electrical Contractor shall retain full responsibility for the Services Installation and System operation.

The Electrical Contractor shall be responsible for ensuring that the "Working Drawings" are fully co-ordinated and compatible with the structure and other elements as applicable.

The Electrical Contractor shall include for the design development of the scheme indicated on the tender information through to completed installation. This shall include all design development costs, and associated installations costs, including the supply, erection, fixing, connecting, setting to work, testing commissioning and maintaining in accordance with the manufacturers recommendations of the entire works as described in this specification, on the tender drawings and as may be reasonably inferred as necessary.

2.3 Design Calculations

The Electrical Contractor as part of the detailed design will produce the following calculations as a minimum:

- Electrical maximum demand calculation.
- Detailed cable calculations on all disconnection times, earth fault loop impedance, short circuit protection and discrimination, including volt drop, current carrying capacities of cables, space factors, grouping etc. to establish sizes for all cables and equipment on in line with BS7671 produced on Amtech, etc. Amtech .p17 file issued to BEC for comment and approval.
- Protective device discrimination graphs / Study on approved software such as Amtech. Amtech .p17 file issued to BEC for comment and approval.
- Protective and equipotential bonding conductor sizing calculations or as Table in IEE Wirings Regulations.
- Schedule of loads including diversity values.
- Complete building lighting design calculations, including provision of Isolux diagrams, photometric data and glare calculations on Dialux / Relux software.
- Completed building emergency lighting calculations on Dialux / Relux software
- Containment sizing calculation for all containment runs.
- Lightning protection risk assessment.

2.4 Technical Submission

The Electrical Contractor shall provide a full set of technical submittals for every service including full product details for comment/approval by BEC.

2.5 Drawings Submission

The Electrical Contractor shall provide a full set of installation drawings for comment/approval by BEC prior to installation. This shall include but not be limited to the following:-

- NTS LV Schematic
- NTS Earthing Schematic
- 1:50 Design layout drawings for each internal service
- 1:100 Combined incoming utilities setting out drawings
- 1:100 External lighting layout including controls schematic
- 1:50 Lightning protection layout
- 1:50 Reflected ceiling plan layouts
- 1:50 Full set of coordinated layouts and sections showing mechanical, electrical and CLT layouts
- 1:20 Plantroom layout
- 1:50 Details of access panels required for maintenance

2.6 AutoCAD

The Electrical Contractor shall allow for completing the project using AutoCAD 2017 to show full co-ordination of M&E services with other disciplines.

2.7 Scope of Works

2.7.1 General

The Electrical Contract includes, but is not limited, to the following elements of work: -

- Full detailed design responsibility

- Liaison with incoming electrical services provider as required by the main contractor, and completion of application forms
- Liaison with the incoming BT services provide as required by the main contractor, and completion of the applications forms
- Electrical switchgear and sub-main distribution
- Bracketry, primary and secondary containment
- Power and data cabling
- Internal lighting
- External lighting
- Emergency lighting
- Lighting controls
- General Small Power
- Voice and Data installation
- Fire alarm system
- Intruder alarm system
- CCTV installation
- Disabled toilet alarm system
- Lightning protection installation
- Earthing and Bonding installation
- Electrical requirements for mechanical services
- Provision of labelling and charts
- Testing and commissioning
- Provision of spares
- Provision of Operating and Maintenance manuals, drawings and product literature
- Provision of the Building Log Book
- Provision of Building Users Guide

The following items shall be excluded from the electrical package:

- Procurement of and payment for incoming services (By Main Contractor)
- White goods and domestic appliances
- Active "IT Equipment"

The electrical installation shall be carried out using Twin and Earth LSF cabling run on galvanised steel cable basket and where cables drop to low level within the meeting room and office these shall be contained within surface mounted 2 compartment dado trunking.

Sub-main wiring shall generally be XLPE/SWA/LSF cables installed on medium duty cable tray.

The installation shall generally be concealed within the building structure / fabric apart from the plant room where the installation shall be surface.

The small power installation shall be installed to comply with Section 543.7 of Chapter 54 of BS7671- The Wiring Regulations, i.e. to comply with the earthing arrangements for items of equipment with high earth leakage currents.

2.8 General Cabling Installations

2.8.1 Excavations Associated with Cable Installations

All trenches for cables must be straight between points where there are changes in direction.

Trenches must not have step changes in level, but be gradual where needed.

The bottom of trenches must be smooth and free from stones.

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.

Means are to be proposed to the Engineer, to minimise the effects on works traffic caused by any excavations during the execution of the work.

Where appropriate, the various work schedules attached to this document will define the scope of trenching and builders work associated with the cable installation. Where trench depths exceed 1.2m, trench boarding must be provided.

Where other services are encountered, during excavation, adequate support and protection must be provided particularly when digging, backfilling and cable pulling.

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.

2.8.2 **Cable Installation in Trenches**

Cables must be laid in the trenches using roller, or other approved devices, to prevent dragging, and consequent abrasion.

Where more than one cable is to be laid in trench, a minimum horizontal space of 300mm must exist between adjacent cables unless otherwise specified.

Cables must be laid on a bed of not less than 75mm of soft sand and covered with a further 75mm of hand compacted soft sand. Sifted soil may be used as an alternative, subject to approval.

Earthenware, concrete or 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.

Backfilling must be compacted in layers not deeper than 300mm and the final surface reinstated so that after settlement it must be consistent with the surrounding surface level. Surplus material must be disposed of.

On completion, there must be at least 750mm cover above the cable to the finishes ground surface.

The ground surface finish on completion must be similar to that in the immediate area.

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.

Where lengths of cable in excess of 100m are required, precautions against thermal expansion and contraction must be taken.

Plastic cable marking tape must be laid 50mm above the cable tiles. The tape must be yellow with "Danger Electricity" printing along its length.

Cable marking tape must also be laid above the cables and at a maximum depth of 150mm below ground level and must be snaked to cover the width occupied by the cables.

Where cables are to be laid along routes on which the ground will not be made up to its final level immediately following the cable installation, the routes must be marked by temporary notices indicating the danger present, over the total length of the route involves. Markers must not be spaced at greater than 10m intervals. All temporary markers must be of a durable weatherproof nature and be approved.

2.8.3 **Cable Installation within Ducts**

Cable ducts must be of reputable manufacture and must be made from uPVC unless otherwise specified and shall be a minimum 150mm diameter. The ducts must be laid and bedded in such a way as to prevent damage from rocks etc. within the trench or in the back filling materials.

Cables are to be installed by use of a cable pulling sock applied to the cable over sheath.

The maximum cable pulling force should not exceed 6KG per m^2 for copper cables or 3KG per m^2 for Aluminium cables.

Where cable routes are designed to pass under areas of hard standing or through foundations etc., the cables must be enclosed in pipe ducts or sleeve.

The protection of ducts running under roads etc. will be by concrete haunchings or other approved suitable means.

The provision of cable draw pits at points of route deviation, and the transition from open ground to ducts must be agreed with the Engineer. The dimensions of the draw pit must be determined with the Engineer taking into account the number, type and size of the cables involved. Deep draw pits must be of a sufficient size to allow access to the lowest ducts.

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 space ducts must be sealed against ingress of water and or vermin, with proprietary products approved by both the duct and cable manufacturer.

A nylon draw cord must be left in each spare duct.

Before cables are drawn into any ducts, new or existing, the ducts must be swabbed to ensure that it is free of debris and clean.

Before cables are drawn into ducts the entry points must be protected to ensure that there is no damage to the outer serving of the cable during the pulling operation.

Following the drawings in of the cable, the duct must be sealed using materials or devices authorised to provide protection against vermin, passage of gases etc.

2.8.4 **Cable Installation Above Ground**

Cables installed above ground level must be fixed onto suitable rust resistant cable racks as detailed above, using saddles or cleats of approved design. Fixings and supports must be selected and installed in accordance with IEE Regulations, Cable manufacturers recommendations and associated guidance notes to prevent any undue strain being imposed on cables.

Where existing steelwork logically forms a part of the cable route, approval for its use must be obtained in writing.

No welding, cutting or drilling or deformation of any steelwork will be allowed unless approved.

Any additional steelwork required for the support of cable racks, must be provided by the installer, details of the construction, size, steel quality, finish etc. must be submitted for approval.

Where a single cable is to be run along a wall, the cable may be fixed directly to the structure, without a cable rack, providing the route and fixing method are approved.

Cables must be supported using approved clamping units in such a way as to minimise sagging, without limiting the free circulation of air around the cable and suitable to withstand any forces imposed under fault conditions.

Where routes involve multiple cable runs, the lay of the cables must be such that crossovers are eliminated, wherever possible.

Cables must not normally be installed in positions where they may be affected by heat from adjacent services, pipes etc. Where close approach is unavoidable, the use of baffles, or other means, may be proposed for approval to mitigate cable exposure to heat.

2.8.5 **Mechanical Protection of Cables**

Where cables are exposed at or near ground / floor level, a steel guard must be fitted over or round the cables. The details of the proposed construction must be submitted for approval before fabrication. The protection must extend from floor level to a height of 2m for vertically rising cables.

Where cables are protected as above, care must be taken to provide adequate air space, and air flow to ensure that the cable installation design criteria are not compromised.

2.8.6 **Buried Cable Route Marking**

Route marking blocks of an authorised design must be set into the ground directly above buried cable. The blocks must carry an indication relating to Electrical Cables below, and also include basic cable details – type, voltage, depth etc. – and the direction of the cable route leaving the marker.

Route marker must be placed at intervals not exceeding 20m on straight runs.

A route marker must be placed at every change of direction of the cable concerned. Route markers must be installed so that they are level with the surrounding ground or finishing level.

Joints must be indicated by specific markers directly over the joint.

A marker plate must be fixed to walls 300mm above ground level where cables pass from open ground into a building. The wording must be authorised, but must include the words "Electric Cable Below".

2.9 Incoming Electricity Supply

An initial maximum demand calculation has been undertaken by Built Environment Consulting which has indicated that a new 70kVA TPN supply will be required to serve the new development.

BEC have initiated the application process, however BEC are still awaiting a copy of the "Draft" quote. It shall be the responsibility of the Electrical Contractor to carry out their own electrical load assessment and to verify that the aforementioned supply is adequate for the development. The Electrical Contractor shall then liaise with the statutory services to provide a final installation quotation.

The Main Contractor shall procure the incoming services in line with the final quotation provide by the Electrical Contractor.

Utility Company Contact:

Western Power Distribution
3rd Floor
Toll End Road
Tipton
DY4 0HH

Project reference number: TBC

It should be noted that the incoming electrical supply shall be based on a "Whole Current Metered" solution and that 1no. Bill will be provided by the client preferred utility supplier when the building is in full use.

The Main Contractor shall be responsible for procuring the suppliers metering arrangement for the new electrical supply.

2.10 Incoming Telecoms

Provision of new incoming BT services for the new development.

The services consultant (BEC) has already registered the site for this service, although it will be the responsibility of the Main Contractor to obtain the final quote, placing orders and procurement.

The Main Contractor shall be responsible for the supply, installation and making good of all external below ground ducting to facilitate the BT installation.

All duct types are to be are to be agreed with BT prior to procurement and installation of the same.

As a minimum dedicated telephone lines shall be provided as follows: -

- 1no. For the Fire alarm panel (Redcare or equal and approved)
- 1no. For the Intruder alarm panel for (Redcare or equal and approved)
- 1no. Within the admin office
- 1no. Within the meeting room

The Electrical Contractor shall make full allowances for any associated attendances, installation of the free issue CW1308 BT cable between the DP point and telephone outlets, installation of associated cable containment and accessory boxes.

It will be the responsibility of the building owner to register their services with BT upon occupation.

2.11 Low Voltage Switchgear

2.11.1 Scope of Works

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning of a new 125A (16+6) TPN split load lighting and power distribution board as manufactured by Schneider Electric Acti 9 Isobar.

2.11.2 Standards and Guidance

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- BSEN 61439-3:2012 Low-Voltage Switchgear and Control Gear Assemblies
- IEC 61439-3:2012 Low-Voltage Switchgear and Control Gear Assemblies

2.11.3 System Design Criteria

The Low Voltage Switchgear shall be located within the designated plant room area. The Electrical Contractor shall undertake a space planning exercise in conjunction with the Main Contractor, Mechanical Contractor and other specialist trades to ensure adequate space is provided within the plant room to facilitate to Low Voltage Switchgear installation and leaving a minimum of a 1000mm stand back for maintenance reasons.

All TP&N distribution boards are to be factory assembled composite units, complete with suitably rated busbars, interconnections, miniature circuit breakers, RCBO's of the appropriate type and rating.

The Electrical Contractor shall ensure that a 25% minimum spare capacity is allowed for within the distribution board both physically and electrically to facilitate any future installations.

The main incoming isolator on the TP&N distribution board shall be AC23 rated as a minimum.

The distribution board must be tamper and vandal resistant.

The distribution board shall be fully lockable with barrel type locks and shall be supplied with blanking plates as required. Locks shall be provided to ensure that one master key can open all distribution boards. Circuit references on the pan assemblies shall be neatly labelled with indelible ink.

The Electrical Contractor shall allow to supply and install MCB / RCBO protective devices based on the following and with a minimum fault rating of 10kA: -

- Final Lighting Circuits – Type C BSEN 61009-1 c/w 30mA trip
- Final Small Power Circuits – Type B BSEN 61009-1 c/w 30mA trip
- Final Circuits for Mechanical Services – Type B/Type C BSEN 61009-1 c/w 30mA trip
- Final Circuits for Fixed Equipment – Type B BSEN 61009-1 c/w 30mA trip
- Final Circuits that are sensitive to high earth leakage – Type B / Type C BS EN 60898 MCB's

The Electrical Contractor shall be fully responsible for ensuring that full electrical discrimination is achieved throughout the low voltage distribution network.

The Electrical Contractor shall allow to supply and install two energy meters within the split load distribution board to monitor the load utilised by the lighting and small power separately.

The energy meters shall utilise a pulsed output communication facility.

The Electrical Contractor shall allow for the supply and installation of BS921 insulated rubber matting, which shall be laid on the floor in front of the LV distribution board prior to practical completion / handover.

2.11.4 Equipment and Materials

All electrical switchgear utilised shall be as manufactured by: -

- Schneider Electric
- Hager

2.11.5 Testing and Commissioning

All testing and commissioning carried out on the Low Voltage Switchgear Installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671.

The Electrical Contractor shall allow to install a full set of testing and commissioning certificates within the front cover of the TP&N distribution board at the time of practical completion.

2.12 Earthing and Bonding

2.12.1 Scope of Works

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning of an Earthing and Bonding installation through the development.

2.12.2 Standards and Guidance

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- BS7430 Code of Practice for protective earthing of electrical installations

2.12.3 **System Design Criteria**

Adjacent to the main distribution board a copper earth bar shall be installed and mounted vertically.

The earth bars shall form a collection point for all main earth cables.

The earth bar shall include, but not be limited to, the following connections:

- Earth bond to incoming electrical supply
- Lightning protection system (Where required by BSEN 62305)
- Earth bond to water
- Earth bond to gas
- Earth bond to mechanical services
- Test Link
- Earth Rod

All conductors shall be terminated on their respective metallic parts via a BS 951 clamp or other suitable method and bear the 'SAFETY ELECTRICAL CONNECTION DO NOT REMOVE' warning notice.

All metallic fixed tables, equipment and exposed pipework shall be equipotentially bonded.

2.12.4 **Equipment and Materials**

The Electrical Contractor shall allow to supply and install earthing and bonding cables that are BASEC approved, Green and Yellow in colour and including LSF insulation.

2.12.5 **Testing and Commissioning**

All testing and commissioning carried out on the earthing and Bonding Installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671.

All bonding connections shall be accessible for inspection, testing and maintenance purposes.

2.13 **Cable Containment and Wiring System**

2.13.1 **Scope of Works**

The Electrical Contractor shall allow for the design, supply, install, test and commission a cable containment and wiring installation through the development.

2.13.2 **Standards and Guidance**

- BSEN 61537 – Cable management – Cable tray systems and cable ladder systems
- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015

2.13.3 **System Design Criteria**

2.13.3.1 **Cable Containment**

The Electrical Contractor shall be responsible for sizing all conduits, trunking, cable trays and cable baskets. Where sizes are indicated in the specification or on the drawings the Electrical Contractor shall be responsible for reviewing the size and shall ensure that costs are included for all containment to meet the following criteria:

Cable trays sized with all cable flat and touching in a single layer with minimum 20% spare capacity.

Cable baskets, sized with cables bunched but within the depth of the basket with minimum 20% spare capacity.

Any cable and trunking routes identified on the tender drawings are notional and while they have been coordinated as far as possible with other disciplines and services, it shall be the Electrical Contractors responsibility to locate and agree the routes with the architect, structural engineer and main contractor.

The Electrical Contractor shall take full responsibility for the coordination of the containment systems and shall ensure that sufficient containment is allowed for the mechanical services.

This requirement shall not alleviate the Mechanical Contractors from their responsibility of working closely with the Electrical Contractor in ensuring a full and complete containment system has been provided.

Common supports and hanging systems shall be used to maximise the use of available voids and containment routes. All supports shall be supplied and installed by the Electrical Contractor.

2.13.4 **System Description and Operation**

2.13.4.1 **Low Voltage Containment**

Low voltage containment for final circuit wiring shall be a mixture of galvanised cable basket with secondary runs in galvanised metal conduit where drops are made to low level electrical accessories. All conduit drops are generally to be flushed finished throughout the building apart from the plant rooms and store where a surface installation would be acceptable.

The Electrical Contractor shall design and develop the necessary arrangement to accommodate the required number of vertical connections to the primary containment systems. The positioning and arrangement of the vertical connectors shall be carefully detailed and coordinated with the building features and in conjunction with the architect.

Surface fixed containment shall be used within plant rooms, stores and vertical risers; conduit shall be galvanised steel fixed using spacer bar saddles.

Earth tags shall be fitted to all cable baskets to provide electrically continuous wire way system.

2.13.4.2 **Containment for Specialist Installation ELV Wiring**

Specialist ELV wiring for systems such as fire alarm system and CCTV system etc. shall be installed on a dedicated galvanised steel cable basket. Other than for fire alarm system wiring (which is mechanically protected by construction) all other specialist installation wiring shall be installed in suitable conduits from the cable tray/basket to the point of use.

2.13.4.3 **Containment for Structured Cabling Installation**

A complete and continuous wire way containment system shall be provided for comms cabling, comprising the voice and data structured cabling installation. The primary and secondary containment system shall be a cable basket system installed above demountable suspended ceilings.

The containment system shall be continuous and shall include tertiary run outs through to the point of use outlet. Tertiary run outs shall be concealed conduits. The Electrical Contractor shall allow for the provision of all containment within the comms and Server Rooms to connect the comms racks / cabinets to the high level primary containment.

Dado trunking where deployed shall be surface fixed; it shall be selected and installed in a manner compatible with the technical performance requirements of a Cat 6 structured wiring installation. The dado trunking shall incorporate a metallic spray coating or a metallic partition / liner between the mains and comms wiring compartments. It shall be assumed that the comms wiring will incorporate the larger trunking compartment.

Back boxes shall be provided for all structured cabling points; the use of dual outlet points shall be assumed. Back boxes shall be suitable for a Cat 6 cable installation subject to a minimum 35mm deep, and subject to confirmation of specialist's requirements. Cabling for the data infrastructure will be of the CAT 6 type.

The Electrical Contractor shall refer to the room data sheet to establish the number of IT points in each room.

A draw wire secured at each end shall be installed in each wire way for use by the specialist supplier/installer.

2.13.4.4 **Dado Trunking**

Dado trunking shall be white 2 compartment PVC-U, including all components.

Dado trunking shall generally follow the guidance above but care shall be taken in placing the dado in sympathy with desk heights and window sill heights etc.

If it is not obvious where to mount the dado, then please seek guidance before installation.

The Electrical Contractor is referred to the room data sheets which indicate where dado trunking is required.

The Electrical Contractor shall note that to meet the requirements of the Disability Discrimination Act (DDA) that the building requires the use of contrasting coloured strips adjacent each accessory.

2.13.4.5 **Cables Concealed in Walls**

Requirements of BS7671 regulation 522.6.6 to 522.6.8 (Cables Concealed in Wall and Partitions)

All socket outlets shall be RCD protected regardless of the containment system adopted.

The building Electrical Contractor shall ensure that clause 522.6.6 and 522.6.7 of BS 7671:2008 - IEE Wiring Regulations 17th Edition, shall be adhered to when considering and designing the containment systems. The Electrical Contractors design shall be based upon the assumption that any subsequent installation shall not be under the supervision of a skilled or instructed person.

It shall also be assumed that the wall construction includes metallic parts other than metallic fixings. The partitions being constructed shall be of the metal stud type.

If doubt over compliance or construction techniques exists, then metal conduits shall be used as a default position.

Please note also the earthing requirements of metallic conduits within the stated British Standard clauses.

The Electrical Contractor shall declare, within their tender return, the methodology adopted. If no statement is made then the best-case scenario shall be deemed to have been provided, which is metallic conduits being provided throughout.

The onus shall be on the Electrical Contractor to prove why metallic conduits have not been used.

The CA shall be informed when such installations are being undertaken to allow an inspection to be completed at the most appropriate time. If no declaration is obtained, and therefore no inspection achieved, then the CA shall reserve the right to have conduit installations 'uncovered' to prove the methodology adopted.

If it is proved that plastic conduits have been used inappropriately the Electrical Contractor shall allow for providing and installing retrospective RCD protection to all electrical circuits at no charge to the contract.

Details of the installation method shall be included within the as fitted manual, with detailed instruction for the maintenance personnel on identifying hidden services and the precautions required for the fixing of FF&E items.

2.13.4.6 **Electrical Main, Sub-Main and Final Circuit Wiring**

The electrical installation shall be designed to comply with the following requirements.

The Electrical Contractor shall also comply with these requirements for the elements which have been listed as "contractor design" or during the design development process:

- BS7671
- Lighting circuit – minimum cable size 1.5 mm2
- Power circuits – minimum cable size 2.5mm2
- Full size cpc's shall be used in all final circuits
- High integrity earthing for all circuits with socket outlets which can be used for PC's and Laptops.

- Unless specified otherwise no ring mains shall cover an area exceeding 100m2
- Residual current detection (RCD) protection 30mA to ring main circuits feeding cleaners sockets and other accessible socket outlets in public / circulation spaces
- Lighting circuits – minimum mcb size 10A, maximum design current 6A and maximum of 12 points
- Ring main circuits – mcb size 32A, maximum design current 24A
- Radial circuits – mcb size 16A or 20A, maximum design current 75% of rating.

The Electrical Contractor shall be responsible for undertaking the cable calculations and ensuring that they are maintained to reflect the actual installation being provided on site. All material changes shall be managed and re-calculated by the Electrical Contractors with new calculations being submitted to the CA/design team for comment.

Those areas designated "IT Areas" will be wired in accordance with the requirements of BS761 section 543.7 of Chapter 54 for areas with a high-density PCs, etc. and shall be provided with suitably sized surge protection devices.

2.13.5 Equipment and Materials

All cable containment utilised shall be as those manufactured by: -

- Mita
- Marshall Tufflex
- MK Electric

All cables utilised as part of the installation shall be BASEC approved and shall have LSF insulation.

2.13.6 Testing and Commissioning

All testing and commissioning carried out on electrical installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671.

2.14 Small Power

2.14.1 Scope of Works

The Electrical Contractor shall allow for the design, supply, install, test and commission of a small power installation throughout the development.

2.14.2 Standards and Guidance

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- Disabled Discrimination Act
- Building Regulations – Approved Document M

2.14.3 System Design Criteria

2.14.3.1 Electrical Accessory and Equipment Mounting Heights

Wall mounted wiring accessories, equipment and boxes shall be mounted at the following dimensions above finished floor level to the bottom of accessory plate:

Any ambiguities shall be referred to the Services Consultants prior to installation.

Light switches	-	1100 mm
Socket outlets	-	normal 450 mm
	-	above worktops 150 mm or mounted on dado
Socket outlets to kitchen	-	350mm above worktops to avoid splash back
Telephone and data outlets	-	normal 450 mm
	-	above worktops 150 mm or mounted on dado
Wall mounted uplighters	-	2000 mm
Wall mounted thermostat &heat detectors	-	1400 mm
Fire alarm panel fused spur	-	2100 mm
Break glass call points	-	1100 mm
Fire alarm sounders	-	2000 mm
Hand dryers	-	standard 1200 mm disabled 1000 mm

2.14.3.2 **Part M Requirements**

Light switches for use by the general public are to align horizontally with door handles within the range of 900mm to 1100mm for ease of location when entering a room.

Wall mounted socket outlets and data/telephone points are located between 450mm and 1000mm above the floor, with preference at the lower end of the range. Switches for permanently wired appliances are to be located between 450mm and 1200mm above the floor, unless needed at a higher level for particular appliances. Controls that need close vision are to be located between 1200mm and 1400mm above the floor so that readings may be taken by a person sitting or standing (with thermostats at the top of the range).

The Electrical Contractors shall note that to meet the requirements of the Disability Discrimination Act (DDA) that the building requires the use of contrasting coloured strips adjacent each accessory.

Note: Part M of the Building Regulations shall take precedent where specific consideration is required for a given environment.

2.14.4 **System Description and Operation**

2.14.4.1 **General Small Power**

The Electrical Contractor shall install general small power around the building to suit the quantities indicated on the room data sheets and as required to provide a full working and compliant M&E system.

The Electrical Contractor shall allow to liaise with the Architect, Main Contractor, Consulting Engineer and Client in regard to the final positioning of all electrical accessories, especially where the installation is to be co-ordination with FF&E and kitchen appliances.

The electrical contractor shall ensure that no more than 8no. Twin Socket Outlets are wired from each ring main circuit.

The Cleaners Sockets are to be wired on their own ring main circuits and protected by a 32A type C 61009 RCBO device.

13A Twin Switched Socket outlets complete with USB charging points are to be installed within the office and the meeting room as indicated on the room data sheets.

All electrical spurs and isolators are to be labelled utilising "Dymo" tape to identify the equipment they serve including the full final circuit reference such as "DB1/1/L1".

2.14.4.2 **Small Power for Mechanical Services**

The Electrical Contractor shall size electrical supplies terminating in suitably rated rotary isolators for each item of mechanical plant and as indicated on the room data sheets. The Electrical Contractor shall be responsible for the provision of all necessary containment systems, as previously described, in order to install the electrical supplies.

The Electrical Contractor shall allow for full and appropriate liaison with the Mechanical Contractor to fully understand the electrical supply and containment requirements for the mechanical services installation.

The Electrical Contractor shall allow for liaison with the Mechanical Contractor to fully understand the control philosophy and extent of the containment and controls wiring required for mechanical equipment.

The Electrical Contractor shall be responsible for providing power supplies to the local wall/duct mounted extract fans, under floor heating manifolds, CO2 monitors, electric water heaters etc. including all final connections from the electrical isolator to the mechanical services plant and equipment.

Generally, extract fans shall be fed via the local lighting circuit unless detailed otherwise and controlled ether by local on/off switch or via the lighting PIR presence detector.

Unless otherwise stated cables shall terminate adjacent to each fan unit at a three-pole fan isolator to BS EN. 60947-3:1992

2.14.4.3 **Wiring Accessory Finishes**

The wiring accessories shall generally be provided as follows to suit the area they serve:

Kitchen Areas	-	White plastic finish
Plant Rooms	-	Metal clad finish
Circulation Spaces	-	White plastic finish
Offices and Meeting Rooms	-	White plastic finish
Toilets	-	White plastic finish
Stores	-	Metal clad finish

It should be noted that where electrical accessories are mounted within dado trunking the installation shall be complete with "colour contrast" strips either side of the accessory for DDA compliance.

Accessories shall have dual earth connections for compliance with sections 543.7 of Chapter 54 of BS 7671.

2.14.5 **Equipment and Materials**

All small power accessories utilised shall be as those manufactured by: -

- MK

2.14.6 **Testing and Commissioning**

All testing and commissioning carried out on electrical installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671.

2.15 **Lighting and Control Installation**

2.15.1 **Scope of Works**

The Electrical Contractor shall allow for the design, supply, install, test and commission of a lighting and control installation throughout the development.

2.15.2 **Standards and Guidance**

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- BSEN 12464-1 – Lighting of indoor workplaces
- BSEN 12464-2 – Lighting of outdoor workplaces
- LG6 – The exterior environment
- LG12 – Lighting for the built environment (Emergency Lighting)
- BS5266 – Code of practice for the emergency lighting of premises
- BSEN 1838 – Lighting applications – Emergency Lighting

2.15.3 **System Design Criteria**

2.15.3.1 **Illumination Levels**

Illumination levels shall adhere to the CIBSE Code for Lighting.

Space	**Illumination Level (lux)**	**Glare Index**	**Colour Rendering (Ra)**
Office spaces	500	19	80
Entrance areas	200	22	80
Circulation areas, corridors	150	25	80
Store rooms	100	25	80
Plant Rooms	200	25	80
Main Hall Plant Deck	200	25	80
Kitchen / Servery	500	22	80
External perimeter Walkways	5	50	20
External Main Entrance	20	50	20

If there are any discrepancies between the above, room data sheets and the tender drawings then the requirements of the British Standards, CIBSE guides, ILE guidance notes shall take precedence.

All internal and external luminaires shall utilise LED lamps and to a 4000k colour temperature unless overridden by the local planning authority or advised otherwise during the detailed design process.

2.15.3.2 **Control Gear**

Where dimming of luminaires is required, luminaires shall be supplied with DSI type control gear.

Where dimming is not required, standard high frequency control gear shall be provided.

All control gear shall be supplied from the OEM of the luminaires specified.

The Electrical Contractor shall ensure that all control gear operates with, and is compatible with, the lighting control system.

2.15.3.3 **Emergency Lighting**

The Emergency lighting shall be provided to cover the whole of the building and to the following specific locations:

- Specific Hazards.
- Fire Fighting and First Aid Equipment.
- All Toilets.
- Exits external in the immediate vicinity of final exits to aid safe evacuation.
- Electrical riser cupboards, distribution board and control panel locations.

The emergency lighting installation shall consist of a mixture of integral NM3 emergency battery packs, self-contained NM3 emergency luminaires utilising LED lamps.

All emergency lighting circuits are to be tested via a bank of key switches located adjacent to the distribution board.

A comprehensive system of internally illuminated exit signs, to meet BS5489 and European Legislation, shall be provided and installed by the Electrical Contractor to form part of the emergency lighting installation.

2.15.4 **System Description and Operation**

2.15.4.1 **Internal Lighting**

The Electrical Contractor shall note that the strategy drawing provided as part of the tender package shows design intent only. The strategy drawing does show the type of luminaires required in each area, but it shall be the Electrical Contractors responsibility to select the appropriate luminaire quantity, lamp and lumen package for the space in question and to ensure compliance.

Generally internal luminaires specified are LED to meet the requirements of Building Regulations Part L and shall have an efficacy of more than 60 lumens per circuit watt.

It is the intention to create a bright, vibrant and visionary environment to all areas of the building. The illumination of the spaces will aim to aid staff and visitors to have an enjoyable and rewarding time.

All lighting circuits shall be supplied from the lighting section of the split load distribution board.

2.15.4.2 **Internal Lighting Controls**

The Electrical Contractor shall employ the specialist lighting control manufacturer CP Electronics to undertake the design, supply, installation, testing and commissioning the automatic lighting controls.

Lighting control to the corridors, toilets, stores shall be via presence detectors. It should be noted that the presence detectors utilised within the toilets shall also control the local extract fan for "Boost" purposes.

Lighting to the main hall and meeting room shall be manually and automatically controlled via retractive type switching, absence detection to facilitate manual on and automatic off switching.

Manual switching shall be provided to the plant room, plant deck and kitchen.

2.15.4.3 **External Lighting**

Generally, the low-level amenity lighting system shall be comprised of an arrangement of wall mounted bulkheads c/w eyelid attachments and fixed to the façade / perimeter of the building. The majority of these luminaires shall provide the required emergency lighting outside defined exit route doors.

The wall mounted amenity lighting shall be installed to meet the required lux levels. All wiring shall be completely concealed.

2.15.4.4 **External Lighting Controls**

The wall mounted amenity lighting shall be controlled via photocell and time switch assembly.

A manual override switch for all external lights shall be provided adjacent the local distribution board located within the plantroom.

2.15.5 **Equipment and Materials**

All internal / external luminaires utilised shall be as those manufactured by: -

- Dextra
- Thorn
- Whitecroft

2.15.6 **Testing and Commissioning**

All testing and commissioning carried out on electrical installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671.

2.16 Intruder Alarm System

2.16.1 Scope of Works

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning of a new grade 3 intruder alarm system to the development.

2.16.2 Standards and Guidance

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- Codes of NSI (NACOSS)
- BS8243 – Installation and Configuration of intruder alarm systems
- BS EN 50131 – Alarm Systems
- BS4737 – Intruder Alarm Systems in Buildings

2.16.3 System Design Criteria

The intruder alarm system shall include, but not be limited to;

- Main Control Panel
- Dual Tech anti mask movement sensors to all rooms with windows.
- Magnetic door contacts to all external doors.
- Key pad within the main office.
- Sounders to all facades of the building, and to internal areas.

The system will also include external sounders.

All wiring shall be concealed and installed on a continuous wire way system.
The Electrical Contractor shall confirm with the specialist the exact requirements of the system and provide full attendance to provide the necessary containment. The system shall distribute signals a separate dedicated wiring infrastructure.

As part of the contracted works the intruder alarm panel shall be connected to a dedicated BT line to facilitate off site monitoring.

2.16.4 Suggested System Supplier or equal and approved

Swift Fire and Security
Derby Road
Risley
Derby
DE72 3SS

Contact: Mark Palethorpe
Mobile: 07968 765 944

2.16.5 Equipment and Materials

The intruder alarm system / components shall be as those manufactured by: -

- Texecom
- CQR
- Honeywell Galaxy

2.16.6 **Testing and Commissioning**

All testing and commissioning carried out on intruder alarm installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671 and BS4737 intruder alarm systems in buildings.

2.17 **Access Control System**

2.17.1 **Scope of Works**

The scope of works associated with the access control system is currently unknown and therefore the Electrical Contractor shall allow for the provisional sum as highlighted in the Electrical Tender Summary.

It shall be the Electrical Contractors responsibility to confirm that exact brief with the Project Manager, Architect, Consulting Engineer and the Client during the detailed design process.

2.18 **CCTV System**

2.18.1 **Scope of Works**

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning a new dedicated IP based CCTV installation to the whole development.

2.18.2 **Standards and Guidance**

- NACOSS Certification and codes of practice
- Specialist installer shall be NACOSS Gold Approved.
- BS EN 50131
- BS EN 50132-7 European Standard for CCTV Systems
- NCP 104 European Standard for CCTV Systems
- Data Protection Act

2.18.3 **System Design Criteria**

2.18.3.1 **IP CCTV**

All CCTV cameras shall be housed in suitable vandal resistant domes where appropriate. External units will be provided with integral heaters and have the capability of recording good quality images at low lux levels.

The IP CCTV cameras will be a minimum of 4 Mega Pixel recording at no less that 1080P Full HD. Cameras will powered by POE from either the NVR or local POE switch's.

Exterior lighting in the vicinity of CCTV cameras shall be adequate to allow capture of images at night. The system shall be able to provide images at night in low levels of light (2 lux) in the event of failure of some or all of the external lighting.

The data of the CCTV system will comply with NSI-NACOSS.

2.18.3.2 **External IP CCTV Fixed Field of View Cameras**

Fixed field of view cameras shall be mounted within vandal resistant Mini-Domes. They shall be housed within powder coated, metal housings with polycarbonate viewing area to the front. The housings shall be fitted with sunshields and equipped with heater/demister units. The heater/demister shall be thermostatically controlled. The camera/housing assembly to be fixed to the building by a purpose made standoff arm.

All external CCTV cameras must cover the perimeter of the building and shall have a masking facility to prevent intrusive visual recording of adjacent properties and especially through private residential windows.

2.18.3.3 **Internal IP CCTV Fixed Field of View Cameras**

Fixed field of view cameras shall be mounted within vandal resistant Mini-Domes. Cameras shall be installed within high impact dome housings built to withstand even the harshest environments. An advanced pivoting axis shall let the user position the camera at exactly the angle they desire, while optimal white balance provides the clearest, most colour-perfect images possible.

Internal fixed field view cameras shall be installed to provide full coverage of the main entrance foyer, internal lobby, hall, office, kitchen, meeting room and store room.

2.18.3.4 **CCTV Monitor**

To provide access to digital images a 22-inch LCD flat panel monitor shall be installed. The monitor shall provide Full HD high-resolution display of computer or motion video signals via multiple inputs. The displays offering up to 1920 x 1080 resolutions and connected with either an HDMI cable or VGA to the NVR.

The monitor shall include VESA compliant mounting holes and can be easily adapted to the available wall or pole mounts.

1no monitor will be required, this shall be located in the main office.

2.18.3.5 **Digital Recording**

All of the cameras incorporated within the system are to be wired and connected to a central Network video recorder (NVR) located in the server room. The NVR will have a built in POE switch to power all the IP cameras and a digital storage capacity of storing 31 days of images.

The proposed digital recording solution shall consist of Network video recorders (NVRs). Features to include: -

- Real Time Recording
- Intuitive User interface
- Remote client allows monitoring / control via LAN or WAN
- Powerful search & export for ease of searching data by time, date etc.
- Customize camera views for flexible monitoring
- Respond to events with alarm-triggered dome positioning
- Record higher frame rates per second for certain cameras and assign the remainder to less critical cameras
- Easily export video, audio and text to DVD+RW or USB Stick
- Digitally authenticated Video
- POE cameras

Recorded images from any of the cameras shall be capable of being displayed on any of the monitors and the NVR shall be equipped to allow images to be archived onto other media.

2.18.3.6 **Digital Recording**

Once images and text are recorded, define the type of recorded events you want to see and Smart Search instantly locates and replays them with digital precision. Video Analysis Tools and Advanced Text are now part of Smart Search so the users may search based on the dynamics of motion as well as the content of a transaction, all while recording live events. With the ability to set cameras to covert, audit the activity log and simultaneously view multiple angles of a single recorded event.

2.18.4 **Suggested System Supplier or equal and approved**

Swift Fire and Security
Derby Road
Risley
Derby
DE72 3SS

Contact: Mark Palethorpe
Mobile: 07968 765 944

2.18.5 **Equipment and Materials**

The CCTV system / components shall be as those manufactured by: -

- Hikvision
- Dahua
- Bosch
- Axis
- Hik

2.18.6 **Testing and Commissioning**

All testing and commissioning carried out on CCTV installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671 and the codes of NACOSS.

2.19 **Fire Alarm System**

2.19.1 **Scope of Works**

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning a new dedicated Category L1 analogue addressable fire alarm system for the new development.

2.19.2 **Standards and Guidance**

- BS5839- Fire detection and fire alarm systems
- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015

2.19.3 **System Design Criteria**

An analogue addressable fire detection and alarm system shall be installed to meet the requirements of the DfES, British Standards BS 5839, local Building Control and the Building Insurers. The system shall comprise individual smoke and heat detectors, sounders, xenon beacons, break glass units, relay and interface units.

A new Gent Vigilion fire alarm control panel shall be provided within the main entrance lobby.

Note: - The analogue addressable fire alarm system must be "Open" protocol.

As part of the contracted works the fire alarm panel shall be connected to a dedicated BT line to facilitate off site monitoring.

Then fire alarm control panel shall be electrically fed directly from the main TPN distribution board.

The system shall include for automatic smoke and heat detection, combined electronic alarm sounder beacons, call points, interface relays and zonal isolators, as required to present a complete installation.

All ceiling voids 800mm or greater in terms of depth shall be covered by ceiling void automatic detection to meet the requirements of BS5839.

All break glass call points are to be complete with polycarbonate covers to prevent accidental activation.

The Electrical Contractor shall take into account the building structure and the need to provide detectors to ceiling voids, equipment risers and plant spaces where required to comply with the standards and this specification.

The system shall be cabled in suitable fire rated cabling. Generally, fire rated cabling shall be soft skin type (enhanced grade PH120 as stated in BS 5839-1: 2002) to CWZ category to BS6387 with copper conductors and an overall red sheath of LSF material and installed on galvanized cable basket.

Enhanced cable types shall be used.

Interface units will automatically isolate the power supplies to incoming gas supply, kitchen roller shutter and shut down any central ventilation systems. Local fans, e.g. wall fans, will be switched off manually by those present.

20% spare capacity shall be provided on all Fire Alarm loops to allow additional points/devices to be connected.

The Electrical Contractor shall design, install, commission and certify the fire alarm installation in compliance with BS 5839. Cable joints shall not be permitted.

Audibility tests shall be undertaken on completion of the works, including the taking of sounder levels in all areas with Normal Plant in operation.

2.19.4 **Servery/Kitchen Roller Shutter**

The Electrical Contractor shall allow to design, supply, install, test and commission the power supply and fire alarm interface associated with the operation of the Servery/ Kitchen fire rated Roller Shutter.

The operation of the Fire Rated Roller shutter under alarm conditions shall operate as per the agreed fire strategy.

The Fire Rated Roller Shutter shall be design, supplied, installed, tested and commissioned by a specialist appointed by the Main Contractor.

2.19.5 **Suggested System Supplier or equal and approved**

Swift Fire and Security
Derby Road
Risley
Derby
DE72 3SS

Contact: Eddie Willis
Mobile: 07968 765 734

2.19.6 **Equipment and Materials**

The Fire Alarm system / components shall be as those manufactured by: -

- Gent
- Advanced Electronics
- Apollo XP95
- Morley

2.19.7 **Testing and Commissioning**

All testing and commissioning carried out on fire alarm installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations BS7671 and BS5839 Fire detection and fire alarm systems.

2.20 Voice and Data Installation

2.20.1 **Scope of Works**

The Electrical Contractor shall design, supply, installation, testing and commissioning of a Category 6 UTP structured cabling system to serve the data requirements of the development.

2.20.2 **Standards and Guidance**

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- IS11801 – Information technology – Generic Cabling for Customer Premises
- BS6701 –Telecommunications Equipment and Telecommunications Cabling
- BSEN 50173 - Information technology – Generic Cabling
- BSEN 50174 - Information technology – Cabling Installation

2.20.3 **System Design Criteria**

All cabling installed shall be in full accordance with TIA/EIA 568 Commercial Building Telecommunications Wiring Standard SP-1907B or later and BS6701 Standards. Where there is a conflict between SP-1907B and any of the clauses detailed within this specification, this specification shall generally prevail, however in such situations the Electrical Contractor shall be responsible for seeking written clarification from the Project Manager.

All Cat 6 UTP cables are to be routed via star topology emanating from the respective data cabinet for the area. Cat 6 UTP cables shall be installed throughout to meet the requirements of ISO 11801 and EIA/TIA 568a specifications.

The cable shall comprise of four inner twisted pairs of cables in an outer sleeve.

Category 6 UTP cables shall only be used on runs up to 100* metre in length.
8100m = 90m of horizontal cable + 7m patching cable and 3 connectors of the same category. Any instances where this cannot be achieved shall be notified by the Electrical Contractor to the Project Manager before installation.

2.20.4 **System Description and Operation**

2.20.4.1 **Passive "Data" Equipment**

The Electrical Contractor shall allow for supplying and installing all Cat 6 cabling, back-boxes and outlet plates, patch plates, media convertors and wall mounted data cabinet as required to complete the installation.

The Electrical Contractor shall allow to liaise with the clients ICT specialist to confirm the final requirements, the following shall be allow for Tender as a minimum:-

1No. 12U Wall Mounted Cabinet located within the main store room.

230V AC mains supplies shall be installed adjacent to the cabinet. 1No. 16A 230V AC Commando socket outlets along with 1No. 6way PDU provided within the cabinet.

2.20.4.2 **WIFI Access Points**

The Client requires the supply and installation of a full managed Wireless Infrastructure.
The Electrical Contractor shall undertake the installation of all power supplies, wiring, containment, fixings and all other items to provide a fully functioning system. Each access point will be provided for utilising a double data outlet located within the ceiling voids at the locations as identified on the room data sheets.

The exact number and location of the managed wireless access points will be determined following a full in depth site wireless audit. The audit will take place when the main fabric of the building is in place.

A number of data outlets have been indicated within the room data sheets, which should be used as a basis of providing a tender return.

The AP's will be Power Over Ethernet (POE) and therefore will not require a 230V AC mains supply.

The client shall provide the necessary active equipment and undertake all final connections with the wireless access points.

2.20.4.3 **Data Face Plates**

The Electrical Contractor shall allow for supplying and installing faceplates to match those being provided as part of the small power installation.

All faceplates shall be matching in both colour and material in all cases.

The small power accessory plates being used are detailed earlier in this specification.

2.20.4.4 **Projector and Speakers**

The Electrical Contractor shall allow for supplying and installing a high-resolution projector, projection screen, and audio speakers within the main hall. The final position of this equipment is to be agreed by the Electrical Contractor in full liaison with the Client, Main Contractor and Consulting Engineer during the detailed design process. The installation shall be fully wired by the Electrical Contractor to suit the client's needs.

Also for the purpose of tender the Electrical Contractor shall allow to wire end to end connections including the associated face plates for the following:-

- VGA
- 3.5mm Phono
- HDMI
- Cat 6 Data

The exact client Requirements are currently unknown so for tender purposes please allow the provisional sum which can be identified within the electrical tender summary.

2.20.5 **Equipment and Materials**

The Voice and Data equipment / components shall be as those manufactured by: -

- Brand-Rex
- Ericsson
- Cisco Systems
- LG
- Canon

2.20.6 **Testing and Commissioning**

All testing and commissioning carried out on the data installation shall be in full compliance with the latest version of the 17th Edition Wiring Regulations.

2.21 **Lightning Protection**

2.21.1 **Scope of Works**

The Electrical Contractor shall employ a specialist lightning protection specialist to undertake a lightning protection risk assessment and provide a lightning protection scheme compliant with BS EN 62305.

2.21.2 **Standards and Guidance**

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- BSEN 62305 – Protection Against Lightning

2.21.3 **System Design Criteria**

2.21.3.1 **Down Conductors**

The Electrical Contractor shall liaise with the Main Contractor with regard to the routing of lightning protection conductors and necessary fixings as these will be surface mounted on the building.

Before commencement of the installation, the Electrical Contractor shall satisfy himself that no underground cables, drains or ducts etc. are buried in the vicinity of the proposed electrodes.

Down conductors shall be avoided but where unavoidable shall be hidden behind rainwater pipes etc.

Down conductors shall be cross bonded to the air termination network.
Down conductors shall be formed from PVC sheathed Copper tape. The minimum cross sectional area size of conductor shall be 50mm

Earth terminations from down conductors shall be connected to earth electrodes by means of PVC sheathed copper tape earthing conductors.

The down conductors shall be served by test points located within the inspection housings by means of direct disconnection from the electrode at the earth tape to earth clamp.
Down conductors from the lightning system to a low level building mounted Bi-metallic test joints shall be PVC Sheathed copper. From the low level building mounted Bi-metallic test joint to the earth rod, the conductor shall be PVC Sheathed Copper.

Provision shall be taken at the Bi-metallic test joint to prevent electrolytic action between dissimilar metals

The colour of down conductors will be selected by the building; The Lightning protection specialist shall provide 1-metre samples of down conductors in the following colours to permit a selection to be made:

- Black
- Green
- Grey
- Stone
- White
- Brown

The lightning protection specialist shall include installing the down conductor in the Buildings chosen colour.

Rods and Earth Inspection Pit Housings.

The lightning protection specialist shall carry out soil resistivity test as British Standard 7430 prior to the installation of earth rods.

The lightning protection specialist shall supply and install earth rods and earth inspection pit housings as required. Each rod(s) shall be no shorter than 4.5 metres in depth.

Earth rods shall be "solid" copper in construction

Earth rod clamps shall be copper in construction

Earth Inspection pit housings will be required at each earth rod location.

The housings shall be a heavy-duty unit manufactured in "polymer". The lid shall be lockable.

2.21.3.2 **Bonding**

The lightning protection specialist shall allow to carry out the following bonding as required by their design:

Metallic structures located near down conductors
Connection of the lightning protection system to the building's main LV earth point/bar.

2.21.4 **System Description and Operation**

The Electrical Contractors appointed specialist shall install the lightning protection as a Faraday cage utilising PVC covered aluminium tapes on the roof and surface fixed to the façade of the building as deemed necessary by the design process in accordance with BSEN 62305.

The Lightning protection system shall be complete with all necessary bonds, fixings, earth pits, copper rods etc. necessary to form a complete operational and safe working system.

The Electrical Contractor shall allow to design, supply, test and commission "Surge" protection within the main distribution board.

2.21.5 **Suggested System Supplier or equal and approved**

Nimbus-Lightning Protection Ltd.
Aspect Court
292 Spring Lane
Lambley
Nottingham
NG4 4PE

Contact: Darren Stapleton
Tel: 0845 006 3134

2.21.6 **Equipment and Materials**

The Lightning Protection equipment / components shall be as those manufactured by: -

- Omega
- Furse

- Dehn

2.21.7 **Testing and Commissioning**

All testing and commissioning carried out on the lightning protection system shall be in full compliance with the latest versions of BS62305.

2.22 **Disabled Toilet Alarm System**

2.22.1 **Scope of Works**

The Electrical Contractor shall design, supply, installation, testing and commissioning of a disabled toilet alarm for the disabled toilet.

2.22.2 **Standards and Guidance**

- 17th Edition Wiring Regulations BS7671:2008 Incorporating Amendment 3:2015
- BS8300 – Design of Buildings and Their Approaches to Meet The Needs Of Disabled People
- Building Regulations Approved Document M

2.22.3 **System Description and Operation**

The disabled toilet alarm shall be complete with a 230V power supply unit, reassurance/rest push button, reassurance light, ceiling mounted pull switch, and sounder/flasher external to the toilet, and all interconnecting wiring.

A 230V SP&N supply shall be provided for the alarm system via a 13A switched fused connection unit, mounted on the wall below the ceiling and labelled 'Toilet Alarm – Do Not Switch Off'. The 13A switched fused connection unit shall be wired on a dedicated 20A radial circuit using a 2.5mm 6491B LSF cable.

The sounder/flasher shall be mounted at high level above the toilet door. The reassurance/reset push button unit shall be 1040mm above finished floor level.

2.22.4 **Equipment and Materials**

The disabled toilet alarm equipment shall be as manufactured by: -

- CTEC Systems

2.22.5 **Testing and Commissioning**

All testing and commissioning carried out on the disabled toilet alarm shall be in full compliance with the latest version of the 17th Edition Wiring Regulations.

2.23 **Hand Dryers**

The Electrical Contractor shall allow for the design, supply, installation, testing and commissioning of all hand dryers in positions indicated within the room data sheets. The specification of these hand dryers shall be as below: -

Airforce Hand Dryer from World Dryer in White.

2.24 **Provision of Labelling and Charts**

The Electrical Contractor shall supply and install a clear labelling system indicating circuit references on each light switch, socket outlet, fused connection unit and isolator etc. The labels shall be Traffolyte engraved labels with black lettering on a white background.

Distribution boards shall be clearly identified and labelled with Traffolyte engraved labels with 10mm high black lettering on a white background. The labels shall be securely fixed with screws.

The Electrical Contractor shall supply type written circuit charts contained within clear plastic wallets fitted securely to the inside of each distribution board. The circuit chart shall contain such information as the circuit type, what it is supplying, design current and cable sizes.

2.25 **Testing and Commissioning**

The Electrical Contractor shall allow for all elements of the electrical installation to be tested and commissioned in accordance with the relevant British Standards.

The Electrical Contractor shall allow for all necessary attendance for the duration of the testing and commissioning by any specialist Electrical Contractor as required.

The Electrical Contractor shall allow to provide copies of all of the electrical installation test certificates at project handover.

2.26 **Electric Shock Notices**

All statutory signage on Electric Shock, First Aid Procedures and Shock warning notices shall be provided and installed by the Electrical Contractor.

2.27 **Provision of Tools and Spares**

The Electrical Contractor shall allow for the provision of spare parts as follows:

- Lamps - 5%, minimum 2No. of each type.
- MCB's - 2No. of each type and rating.
- RCD's - 2No. of each type and rating.

All other spares as per Manufacturer's Recommendations.

All spares to be made available to the Client's representative prior to handover, and a signed receipt shall be obtained from the Client. All spares shall be handed over at the same time.

3.0 MECHANICAL SERVICES PARTICULAR SPECIFICTAION

3.1 Design Responsibility

The Mechanical services design is to be undertaken by the D&B Mechanical Contractor.

The Mechanical Contractors shall be responsible for the detailed design activities listed under the relevant clauses which lists more specific requirements, in addition to those activities normally undertaken through the custom and practice of the industry, all of which are subject to the comments of the Client Representative.

The Mechanical Contractors shall warrant that all reasonable skill and care has been taken in the design of the works in so far as the works have been, or will be, designed by him or by specialist's employed by him.

The Mechanical Contractors shall also take care in the selection of materials and goods to be used in the contract works in so far as the goods are selected by the Mechanical Contractors. He shall also give a warranty on the satisfactory performance of any portion of the works for which the work is detailed within the contract by means of performance specification.

The information detailed on the tender drawings shall be interpreted as being an indicative representation of a minimum level provision; the Mechanical Contractors shall develop these proposals further to provide a full and complete installation.

3.2 Design Development

The aim of the design solution is to provide a low energy scheme which meets the "briefing documents" without detriment to reliability of service or comfort while complying with all relevant legislation.

During the Building Regulation compliance review process the Mechanical Contractors will advise the Contractor of any specialist requirements for the building over and above those already specified.

The Mechanical Contractor shall retain full responsibility for the mechanical services installation and system operation.

The Mechanical Contractor shall be responsible for ensuring that the "Working Drawings" are fully co-ordinated and compatible with the structure and other elements as applicable.

The Mechanical Contractor shall include for the design development of the scheme indicated on the tender information through to completed installation. This shall include all design development costs, and associated installations costs, including the supply, erection, fixing, connecting, setting to work, testing commissioning and maintaining in accordance with the manufacturers recommendations of the entire works as described in this specification, on the tender drawings and as may be reasonably inferred as necessary.

3.3 Design Calculations

The Mechanical Contractor as part of the detailed design will produce the following calculations as a minimum:

- Thermal Model, SBEM Calculation, and as built EPC
- Gas maximum demand calculation.
- Water maximum demand calculation.
- Cold water service pipework sizing.
- Hot, cold and drinking water services pipework sizing.
- Soil and waste pipework sizing.
- Air volume flow rate requirements.
- Pump sizing and selection curves.
- Fan sizing and selection curves.
- Ductwork sizing.
- Pipework sizing.
- Heat losses.
- Boiler plant load.
- Acoustic calculations (provide plant and equipment acoustic information to a specialist)
- Grille and diffuser sizing and selections.

3.4 Thermal Model, SBEM and EPC

The Mechanical Contractor shall allow for as part of their design to undertake their own Thermal Model, and SBEM compliance checks in accordance with the requirements set out in section 1 of this document.

3.5 Technical Submission

The Mechanical Contractor shall provide a full set of technical submittals for every service including full product details for comment/approval by BEC.

3.6 Drawings Submission

The Mechanical Contractor shall provide a full set of installation drawings for comment/approval by BEC prior to installation. This shall include but not be limited to the following:-

- Heating schematics
- Domestic water & gas schematics
- Ventilation schematics
- Drainage schematics
- Plantroom schematics
- 1:50 Design layout drawings for each internal service
- 1:100 combined incoming utilities setting out drawings
- 1:50 Reflected ceiling plan layouts
- 1:50 full set of co-ordinated layouts and sections showing mechanical, electrical & CLT layouts
- 1:20 Plantroom layout
- 1:50 Details of access panels required for maintenance

3.6.1 Mechanical Contractors Design Detailing Responsibility

The M&E Contractors shall be responsible for the detailed design activities listed within this specification and below (unless noted otherwise in the particular technical specification) in addition to and including those activities normally undertaken through

the custom and practice of the industry, all of which shall be subject to the comment of the Engineer.

The M&E Contractors shall be responsible for ensuring that the work, which is undertaken, is fully co-ordinated and compatible with the remainder of the project design.

The M&E Contractors detailing obligations shall include but not be limited to the following:-

- Design and Fabrication drawings and the co-ordinated Installation/Working Drawings and Record Drawings.

- Drain points shall be inserted at all low level positions and vent points at all high level locations, with Auto Air Vents where ever possible.

- Pipework gradients in accordance with BSRIA documents Application Guide 1/89 Flushing and cleaning of Water Systems.

- Bracket and support detailed design and locations. (All types, loads and locations must be declared to the Project Manager prior to installation for comment (10 working days).

- Details of Electrical wiring diagrams of all equipment supplied by the M&E Contractors showing all interconnections between equipment to enable the necessary wiring to be undertaken.

- Details of all equipment component design and selection necessary insofar as such items have been selected by the M&E Contractors for that item of equipment to meet the engineering specification and performance indicated.

- Automatic controls detailed design insofar as it is required to meet with full physical and operational requirements of the Engineering Specification. The Services Contractor shall be responsible for ensuring the full compatibility of the plant and equipment with the specified function. Where interfaces (relays or other devices or modifications to hardware or software) are required the design and incorporation shall be the Services Contractor's responsibility.

- Fire alarm system, component and cabling requirements to meet with particular manufacturer's and the engineering specification's requirements.

- Attenuator design and selection to satisfy the particular and performance requirements of the specification, including spatial allowances made within tender drawings.

- Design of elements of the scheme provided by the M&E Contractors for self-weight and other applied forces/loadings in reasonable use.

- Submit calculations and proposals to demonstrate the design has fully considered the requirements for thermal expansion accommodation and anchorage, including provision of bellows or bends.

- Acoustic design or modification of equipment to meet with the noise levels specified. All levels to be achieved with all M&E operating plant

- Valve, damper and access locations.
- System water capacities, and chemical additives - and arranging of the facilities required by BSRIA Application Guide 8/91 pre-commission cleaning of water system
- Selection of all anti-vibration mountings to suit the particular application of the mounts.
- Final exact locations of control sensors detectors and thermostats.
- Capacity, location and design of electrical conduit system, similarly trunking where used in lieu of multi-conduit installation.
- Duct platforms, access covers and gratings, ladders and additional structural steelwork where required and detailed in the sub-contract documentation.
- Selection of regulation devices to comply with CIBSE Technical Memorandum TM8.
- Sizing of cable terminations on items of equipment provided under the sub-Contract where cable sizes are specified.
- Ensuring cable sizing selections as specified are not invalidated by Sub - Contractor selection of alternative routes during installation.
- Detailed design of earthing and bonding requirements for electrical engineering services, mechanical engineering services, architectural and structural elements requiring earthing and bonding.
- Design of cable or cable trunking terminations on to electrical equipment provided under the sub-contract and dimensioning of and final installation details of electrical switchgear to ensure that:
- Cable entry is possible in the selected location.
- Fuse sizes installed in plug tops are appropriate for the rating of connected equipment.
- Sizing and detailed design of refrigerant pipework between items of equipment provided under contract works.
- Design of discharge stacks /chimney and structural secondary supports
- Detailed coordination and planning of services within Service Risers including provision of plan, section and elevation drawings.
- Phasing, programming and co-ordination of installation activities to minimise disruption and inconvenience to the site.

3.7 **AutoCAD**

The Mechanical Contractor shall allow for completing the project using AutoCAD 2017 to show full co-ordination of M&E services with other disciplines.

3.8 **Scope of Works**

The Mechanical Contract includes, but is not limited, to the following elements of work:-

- Full detailed design responsibility.
- Thermal Model, SBEM Calculation and as built EPC.
- Liaison with incoming water and gas services providers as required by the main contractor, and completion of application forms.
- Incoming Mains Cold Water from the point of the meter and incoming supply termination point as provided by the main contractor
- Incoming Gas Supply and Sitewide Gas distribution from the point of the meter and incoming supply termination point as provided by the main contractor
- Gas Fired Boilers
- Primary & Secondary Heating Pumps
- Heating Pressurisation
- Underfloor Heating System
- Domestic Cold-Water Services
- Domestic Hot Water Services
- Local Extract Ventilation
- Kitchen Supply Ventilation
- Kitchen Extract Ventilation
- Heat Recovery Supply and Extract Ventilation Systems
- Above Ground Drainage
- Heating controls
- Ventilation controls
- Wiring and containment from controls (including power supplies to plant and equipment fed from the controls.
- All wiring carried out under the mechanical contract shall be to the same specification and standards of materials and workmanship as the electrical sections of this document.
- Provision of labelling and charts
- Chlorination of Domestic Water Services
- Testing and commissioning
- Provision of spares
- Provision of Operating and Maintenance manuals, drawings and product literature
- Provision of the Building Log Book
- Provision of Building Users Guide
- Any other item mentioned in this specification or as reasonably inferred as necessary.

The following items shall be excluded from the mechanical & electrical package:

- Sanitaryware.
- Below ground drainage.
- Procurement of and payment for incoming services (By Main Contractor)
- Rainwater
- White goods and domestic appliances

3.9 Incoming Gas Service Supplies

A new incoming gas supply shall be provided to the development as generally indicated on the incoming services drawing. This shall consist of an external gas meter within an external GRP housing.

This supply shall be procured by the Main Contractor, the Mechanical Contractor shall however allow for full liaison with the utility provider to provide a final quotation.

Gas will be distributed internally from the point of the incoming main to the boilers.

An initial gas load calculation has been undertaken by Built Environment Consulting which has indicated that a new supply (circa 30kW) will be required to serve the community hall. The Mechanical Contractor is to carry out their own gas load assessment in order to verify that the aforementioned supply is adequate for the development.

BEC have initiated the application process and obtained an initial quotation. It shall be the responsibility of the Mechanical Contractor to review this quotation and liaise with the statutory services provided to provide a final installation quotation.

The Main Contractor shall procure the incoming services in line with the final quotation provide by the Mechanical Contractor.

Utility Company Contact:

GTC Pipelines
GTC
Energy House
Woolpit Business Park
WoolPit
Bury ST Edmunds
Suffolk
IP30 9UP

01359 240154

Project reference number 34106363

3.10 Incoming Water Supplies

An initial water load calculation has been undertaken by Built Environment Consulting which has indicated a peak water consumption estimated at 0.535l/s to serve the new community hall. The Mechanical Contractor is to carry out their own water consumption assessment in order to verify that the aforementioned supply is adequate for the development.

BEC have initiated the application process with Severn Trent Water. It shall be the responsibility of the Mechanical Contractors to review this quotation and liaise with the statutory services provided to provide a final installation quotation.

The Main Contractor shall procure the incoming services in line with the final quotation provide by the Mechanical Contractor.

Utility Company Contact:

Severn Trent Water Developer Services
Severn Trent Centre
2 St Johns Street
Coventry
CV1 2LZ

024 7771 5000

Project Ref 8290980

3.11 Gas Service Supplies

3.11.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the gas supply as shown on the drawings and as follows:

3.11.2 Standards and Guidance

The contractor shall design, install, test, and commission in order to comply with the following industry standards and regulations as a minimum:

- Install gas pipework in buildings in accordance with BS EN 1775
- Gas supply pipelines for maximum operating pressure up to and including 16 bar to BS EN 12007
- Steel – BS EN 12007-3
- Gas pressure regulating installations on service lines to BS EN 12279
- IGE/TD/3
- IGE/TD/4
- IGE/UP/10
- IGE/GM/1

3.11.3 System Design Criteria

The boiler shall be gas fired and provide space heating to the building.

A 20% increase is applied to the overall heat loss calculation to determine the boiler load.

The incoming gas supply shall be fitted with a manual isolation valve and automatic gas shut off valve, connected to the gas safe control system. The isolation valve shall be in a clear and accessible position.

Refer to the heating section for additional design criteria.

Design Pressure Drops

Gas	-	100 pa maximum pressure loss between Primary Gas meter and the furthest appliance

3.11.4 **System Description and Operation**

Provide gas pipework installations generally as shown on the drawings and comprising:-

- Above ground gas service will be required for the gas fired boiler.
- New internal gas distribution pipework from incoming gas main entry point to the boiler including isolating valves, purge valves, test points etc.
- Provision will be made for an emergency gas shut of solenoid valve and gas proving system on the main incoming supply that will shut off the gas supply in the event of:
- Fire signal
- Heat detectors over boilers
- Manual knock off buttons in basement and or roof level plant room
- Gas proving system not satisfied
- Provision shall be made for metering of the gas supplies. This will include as a minimum:
- Meter on the main gas incomer

All voids, areas or risers containing gas pipework shall be naturally ventilated to the requirements of the Gas Regulations. Wherever the pipe will run in ceiling voids, risers and any unventilated enclosures the gas pipework shall be unjointed Tracpipe (semi-rigid steel pipe complete with protective jacket) and it shall be installed in Plastiflex vented at both ends in ventilated spaces.

3.11.5 **Equipment and Materials Specification**

Pipework and Fittings Specification

Buried gas pipework shall be MDPE, yellow pipework suitable for natural gas.

Gas pipework located internally within the building shall be heavyweight quality black mild steel tube to BS1387.

Pipework shall be painted with red oxide primer paint, and suitably identified as Gas Pipework (by painting yellow orchre).

Install gas pipework and equipment in accordance with IGE/UP/2 and manufacturer's recommendations.

Comply with IGE/UP/10 Installation of gas appliances in industrial and commercial premises.

Comply with Building and Engineering Services Association (B&ES) TR 20/9 Natural Gas.

Gas shut off solenoid valve/gas proving system

The Mechanical Sub-Contractor shall provide and install a **Medem SEC-B** boiler room gas proving, gas detection, auto restart system.

Gas knock-off button shall be provided to the plant room together with electro-thermal fusible links above the boilers. An activation of either of these, or the fire alarm shall close the gas solenoid valve and shut down the boiler plant.

Equipment Supplier:
Medem UK Limited

Project House
19 Dallimore Road
Roundthorn Industrial Estate
Manchester
M23 9NX

0161 233 0600

The electrically operated gas solenoid safety shut off valve (Blacks Teknigas) to be located within the gas pipework arrangement.

Fire mode and manual knock-off button shall be hard wired.

Equipment Supplier:
Watts Industries UK Ltd
Colmworth Business Park
St Neots
PE19 9YX

The aforementioned gas valve, knock of buttons, heat detectors etc are to be installed in strict accordance with Medem requirements.

Commission / test the system and issue a certificate of conformity.

3.11.6 **Testing and Commissioning**

The Mechanical Contractor shall include for connecting all gas outlet points to plant and equipment.

The Mechanical Sub-Contractor shall purge the completed gas installations, using Nitrogen as recommended by the Institute of Gas Engineers Utilisation Procedures to ensure that all "air" is evacuated from the systems.

The Mechanical Contractor shall include to pressure test and approve the complete gas installation, and to produce a signed test certificate to verify that the installation is satisfactory in all respects.

Suitably located test points shall be provided throughout the gas installation by the Mechanical Contractor in accordance with Institute of GEUP documentation.

Copies of all test certificates shall be included within the Operating and Maintenance manual.

Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.

Comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial Natural Gas installations.

The Mechanical Contractor shall provide and display adjacent to the gas meter a full set of gas pipework record drawings showing the completed gas installation in accordance with Section 2 of the specification. Copies of the final layout drawings shall also be included in the maintenance manual.

Provide and fix adjacent all main isolating valves, section valves and master operated valves labels indicating their purpose and position (ON/OFF).

The labels shall be red ivorine with white letterings and the wordings on the labels shall be agreed with the Engineer to suit each individual application.

Encapsulated wall mounted gas schematics for the entire installation shall be installed at the entry point to the plant room.

3.12 Domestic Cold Water Services

3.12.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the domestic cold-water services as follows.

Domestic cold water is to be provided to the following:

- The Ladies toilets: 3no. WCs and 2no. WHBs
- The Accessible WC: 1no. WC and 1no. WHB.
- The Men's WC: 1no. WC, 2no. urinals and 2no WHBs
- The Kitchen: 1no. sink and 1no. dishwasher.
- The plant room: 1no. cleaners sink.

The Mechanical Contractor shall allow to install any sanitary ware that is to be provided by the Main Contractor

3.12.2 Standards and Guidance

The contractor shall design, install, test, and commission in order to comply with the following industry standards and regulations as a minimum:

- BS6700 Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
- BS7592 Sampling for Legionella Organisms in Water and Related Matters
- AG4/94: BSRIA –Guide to Legionella's – Temperature measurements for hot and cold water services.
- ACOP & Guidance: Legionnaires Disease–the control of Legionella bacteria in water systems Health & Safety Legal Series 8
- IOP: Plumbing Guides Services Design Guide
- SI 1989 No 1147 Water Supply Regulations (water Quality)
- The current Model Water Bylaws and the current local Water Supply Authority Bylaws.
- Building Regulations and all current amendments as at the date of tender return
- Requirements of the Local Environmental Health Officer
- All relevant British Standards and Approved Codes of Practice in relation to the works
- CIBSE Guides, Codes of Practice and Knowledge Series Information
- Water Fittings Regulations
- Regulations imposed by local Water Authority
- Chartered Institution of Building Service Engineers Guides and Commissioning Guides
- BSRIA Commissioning guides
- Water Supply (Water Fittings) Regulations 2010
- Meters shall be installed to CIBSE TM39 guidance as a minimum.
- Manufacturer's Recommendations

3.12.3 **System Design Criteria**

The entire cold-water system shall be mains fed. No cold-water storage provision shall be made.

Diversity is applied by using CIBSE demand units, and shall be accepted as an appropriate method to size the incoming water supply.

The incoming mains internal cold water stopcock location shall be accessible and clearly indicated. The buried external stop cock shall be accessible via a removable access hatch.

Design Velocities

Pipework velocities:

15 to 50mm no greater than 1.0 m/s
50 to 150mm no greater than 2.0m/s
NB: Minimum pipework size 15mm nominal bore

Design Pressure Drops

Domestic water services - Maximum 300 Pa/m

Cold Water Temperatures

Cold water – maximum 10°C

3.12.4 **System Description and Operation**

The mains cold water shall enter the building within the kitchen and be complete with a stopcock, drain cock and meter with a wall mounted label as follows:

"INCOMING MAINS WATER STOP VALVE".

The incoming water mains shall have a Hydrotec Hydromag electromagnetic water conditioner installed after the incoming water meter, providing protection to plant and pipework.

Hot water to all outlets other than the dishwasher shall be provided by local electric water heaters, also fed by mains cold water.

All Outlets to all Wash Hand Basins will be fitted with Thermostatic Mixing Valves (TMV3) to limit the temperature of the Hot Water, regardless of the taps utilised.

All cold water service pipework shall be fully insulated in accordance with building regulations. Cold water service pipework shall, where indicated on drawings, be routed within boxing or IPS panels and therefore out of view and insulated.

All connections to appliances and sanitaryware shall be complete with flow limiting/isolation service valves.

All water connections to wash hand basins; sinks, toilet cisterns, etc. will be complete with isolation valves with levers for maintenance.

Also include for the fitting of all taps etc. (supplied by others) to sanitary ware and making final pipework connections.

The Mechanical Contractor shall allow for insulating concealed pipework emanating from the point of entry.

The Mechanical Contractor is to design to the requirements of the water regulations.

Pressure regulation valves shall be installed as and when required to maintain the correct operating pressure of connected sanitaryware fittings.

The whole of the new hot & cold water service will be chlorinated and sterilised on completion of the works.

Legionella testing will be undertaken on the cold water supply on completion of the works.

3.12.5 **Equipment and Materials Specification**

Pipework and Fittings Specification

Mains water (below ground) - MDPE Protectaline (or equivalent) with electrofusion joints.

Mains Hot & Cold water (above ground) - Copper pipework with capillary soldered joints or copper crimp fit pipework.

Pipework within plantrooms, service risers, ceiling voids and exposed within rooms shall be copper piping/copper tubes to BS 2871; Part 1; 1971 - Table 'X' (EN 1057 half hard),

Fittings are preferred to be Capillary and shall be manufactured from copper tube, they may be end feed or solder ring (Yorkshire). Solder shall be lead free on all potable water services. Compression fittings shall only be used at valves and connections to sanitary appliances or on exposed chrome plated pipework.

Water Meters

Installation of a water meter to the incoming Mains Cold Water Supply, shall be by Severn Trent Water at the site boundary.

Equipment Supplier

Elster Water metering Ltd
130 Camford Way
Sundon Park
Luton
Bedfordshire
LU3 3AN

Or equal and approved.

Water conditioner

Due to the hard water in the area the contractor shall provide an electronic water conditioner for the building.

The Water conditioner shall be HydroMag, by Hydrotec sized to match the total building flow rate.

Equipment Supplier

Hydrotec (UK) Ltd
Hydrotec House
5 Manor Courtyard
Hughenden Avenue
High Wycombe
HP13 5RE

01494 796040

Valves

Isolating valves on pipework are to be insulated and shall be Peglar PB350EL, or equal approved.

Isolating valves on pipework not insulated shall be Peglar type PB350, or equal approved.

Service isolation valves shall be fitted to every outlet and these shall be Peglar type CxUN Chrome, or equal approved.

Drain cocks are to be fitted to all low points to facilitate draining and these shall be Peglar type 833LS, or equal approved.

Equipment Supplier

Pegler Yorkshire
St Catherine's Avenue
Balby
Doncaster
South Yorkshire
DN4 8DF

Thermal Insulation

Rockwool Rocklap 800 mineral wool H & V pipe sections, having a nominal density not less than 120 kg/m3 with a factory applied facing which is a laminate of close mesh reinforcement between two layers of foil including integral lap for fixing. The whole to comply with BS5422 (Table 1) and BS5970 water vapour permeance and Building Regulations Class O definition. Thermal conductivity shall be not greater than 0.033 W/mK.

- Pipework insulation shall be applied in strict accordance with the manufacturers recommendations and BS 5970 : 2001.
- All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide adhesive foil tape to provide a permanent and continuous vapour-proof barrier over the insulation. All insulation terminations shall be sealed with tape to maintain the vapour barrier and a purpose made aluminium end cap to maintain a neat appearance.

- Security of sectional insulation shall be reinforced by additional 75mm wide aluminium foil tapes at 330mm centres.
- Bends, elbows, branch connections etc., shall be fully insulated with carefully site fabricated and mitred sections of pipework insulation finished with a neat and fully sealed covering of aluminium tape.
- Pipes or cylindrical vessels requiring to be insulated and having a diameter greater than 325mm, shall be insulated using slab material having closely scored 'V' slots in its inner face.

3.12.6 **Testing and Commissioning**

The Contractor shall thoroughly flush and then chlorinate the whole water system in accordance with HS(G)70 and BS6700 and as detailed below prior to completion and provide test certificates on completion to prove that the whole is in satisfactory condition. The works shall be carried out by a specialist contractor.

All mains cold water pipework shall be chlorinated from (and including) the point of connection to the water authority supply through to the point of supply.

Chlorination shall be carried out as follows:

- Clean and flush out to remove dirt and debris. No water is to be used for domestic purposes during this operation nor until chlorination is completed.
- Prepare the necessary quantity of disinfecting chemical to give a chlorine concentration of 50mg/litre. Follow the manufacturer's instructions.
- Chlorinate new mains or mains extensions first, followed by communication pipes, and supply pipes in that order.
- Add the prepared solution to the pipework, cistern/tank and draw through the system.
- Allow a contact time of one hour after the disinfecting chemical has been drawn through the system.
- Take a sample at the end of the time and check for residual chlorine with a comparator. If less than 30mg/litre is indicated, repeat the process until a residual is obtained.
- Thoroughly flush out to remove all traces of heavily chlorinated water.
- Discharge chlorination water as instructed by the Employer's Agent.

On completion of chlorination the Services Contractor shall provide analysis as follows:

- Take samples from a minimum of 10% draw off points after testing and chlorination.
- Dispatch samples to an approved testing laboratory for bacteriological and chemical analysis.
- Pay all charges for samples and analysis.
- Submit analysis result to the Engineer on receipt.
- Rectify any faults revealed by sample analysis which impair the quality of water beyond the limits set in the EC Directive on the quality of drinking water and pay all charges for re sampling/chlorination.

The Services Contractor shall also check the cold water draw off temperatures at each outlet after 2 minutes.

The water installation shall comply with the current recommendations of the Health and Safety Executive to reduce the risk of Legionellosis. A Legionella Risk Assessment shall

be carried out in accordance with Hs (G) 70. The results shall be included in the operation and Records Manual.

3.13 Domestic Hot Water Services

3.13.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the domestic hot water services as follows.

3.13.2 Standards and Guidance

Where specified, hot water shall be generated by dedicated electric water heaters. Units to be WRAS approved to all current UK Water Supply Regulations and in accordance with Building Control guidance note Part G Sanitation, Hot Water Safety and Water efficiency 2010.

The contractor shall design, install, test, and commission in order to comply with the following industry standards and regulations as a minimum:

- BS6700 Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
- BS7592 Sampling for Legionella Organisms in Water and Related Matters
- AG4/94: BSRIA –Guide to Legionella's – Temperature measurements for hot and cold water services.
- ACOP & Guidance: Legionnaires Disease–the control of Legionella bacteria in water systems Health & Safety Legal Series 8
- IOP: Plumbing Guides Services Design Guide
- SI 1989 No 1147 Water Supply Regulations (water Quality)
- The current Model Water Bylaws and the current local Water Supply Authority Bylaws.
- Building Regulations and all current amendments as at the date of tender return
- Requirements of the Local Environmental Health Officer
- All relevant British Standards and Approved Codes of Practice in relation to the works
- CIBSE Guides, Codes of Practice and Knowledge Series Information
- Water Fittings Regulations
- Regulations imposed by local Water Authority
- Chartered Institution of Building Service Engineers Guides and Commissioning Guides
- BSRIA Commissioning guides
- Water Supply (Water Fittings) Regulations 2010
- Manufacturer's Recommendations

3.13.3 System Design Criteria

The entire hot water system shall be fed by mains cold water.

Diversity is applied by using CIBSE demand units, and shall be accepted as an appropriate method to size the hot water system.

Domestic hot water distribution pipework shall distribute within concealed locations (that being boxing or IPS panels) to serve outlets.

Design Velocities

Pipework velocities:

15 to 50mm no greater than 1.0 m/s
50 to 150mm no greater than 2.0m/s
NB: Minimum pipework size 15mm nominal bore

Design Pressure Drops

Domestic water services - Maximum 300 Pa/m

Hot Water Temperatures

Hot Water – maximum outlet temperature 43 degrees (kitchen sink is exempt)

3.13.4 **System Description and Operation**

The hot water system shall comprise of the following:

The Ladies toilets: 2no. WHBs
The Accessible WC: 1no. WHB.
The Men's WC: 2no. WHBs
The Kitchen: 1no. sink.
The plant room: 1no. cleaners sink.

All rooms identified above shall have a dedicated electric water heater to provide hot water.

All Outlets to all Wash Hand Basins will be fitted with Thermostatic Mixing Valves (TMV3) to limit the temperature of the Hot Water, regardless of the taps utilised.

All hot water service pipework shall be fully insulated in accordance with building regulations. Hot water service pipework shall, where indicated on drawings, be concealed (in boxing or IPS panels) and therefore out of view and insulated.

All connections to appliances and sanitary ware shall be complete with flow limiting/isolation service valves.

All hot water connections to wash hand basins; sinks, etc. will be complete with isolation valves with levers for maintenance.

Also include for the fitting of all taps etc. (supplied by others) to sanitary ware and making final pipework connections.

The Mechanical Contractor shall allow for insulating concealed pipework emanating from the point of entry.

The Mechanical Contractor is to design to the requirements of the water regulations.

Pressure regulation valves shall be installed as and when required to maintain the correct operating pressure of connected sanitary ware fittings.

The whole of the new hot & cold water service will be chlorinated and sterilised on completion of the works.

Legionella testing will be undertaken on the hot water supply on completion of the works.

3.13.5 **Equipment and Materials Specification**

Pipework and Fittings Specification

- Domestic Hot water (above ground) - Copper pipework with capillary soldered joints

Pipework within plantrooms, service risers, ceiling voids and exposed within rooms shall be copper piping/copper tubes to BS 2871; Part 1; 1971 - Table 'X' (EN 1057 half hard),

Fittings are preferred to be Capillary and shall be manufactured from copper tube, they may be end feed or solder ring (Yorkshire). Solder shall be lead free on all potable water services. Compression fittings shall only be used at valves and connections to sanitary appliances or on exposed chrome plated pipework.

All hot water system pipework connections to sinks will be rigid copper pipe to BS EN1057, no flexible connections shall be used.
The Mechanical Contractor shall install appropriately sized flow regulators to the hot and cold connections to all fittings (or ranges of fittings) throughout the building so as to adequately maintain operating pressure.

Valves

Isolating valves on pipework are to be insulated and shall be Peglar PB350EL, or equal approved.

Isolating valves on pipework not insulated shall be Peglar type PB350, or equal approved.

Service isolation valves shall be fitted to every outlet and these shall be Peglar type CxUN Chrome, or equal approved.

Drain cocks are to be fitted to all low points to facilitate draining and these shall be Peglar type 833LS, or equal approved.

All taps and valves must be suitable for operation at mains pressure and temperatures of >65^{o}C.

Equipment Supplier

Pegler Yorkshire
St Catherine's Avenue
Balby
Doncaster
South Yorkshire
DN4 8DF

Electric Water Heaters

Toilets

Inline electric water heaters shall provide hot water to the Ladies toilets, the accessible WC and the men's toilets. They shall be compact electronic instantaneous water heaters with bare wire heating system manufactured by Heatrae Sadia, or equal and approved.

Equipment Supplier

Heatrae Sadia
Baxi Heating UK Limited
Brooks House
Coventry Road
Warwick
CV34 4LL
Or equal and approved.

Plant Room

An unvented electric water heater shall be fitted to the cleaners sink within the plant room manufactured by Heatrae Sadia or equal and approved. The water heater shall be complete with expansion vessel. The water heater shall be switched on/off by a timeclock.

Equipment Supplier

Heatrae Sadia
Baxi Heating UK Limited
Brooks House
Coventry Road
Warwick
CV34 4LL

Or equal and approved.

Kitchen

An unvented electric water heater shall be fitted to the kitchen sink within the plant room manufactured by Heatrae Sadia or equal and approved. The water heater shall be complete with expansion vessel. The water heater shall be switched on/off by a local manual switch within the kitchen.

Equipment Supplier

Heatrae Sadia
Baxi Heating UK Limited
Brooks House
Coventry Road
Warwick
CV34 4LL

Or equal and approved

Thermal Insulation

Rockwool Rocklap 800 mineral wool H & V pipe sections, having a nominal density not less than 120 kg/m3 with a factory applied facing which is a laminate of close mesh

reinforcement between two layers of foil including integral lap for fixing. The whole to comply with BS5422 (Table 1) and BS5970 water vapour permeance and Building Regulations Class O definition. Thermal conductivity shall be not greater than 0.033 W/mK.

- Pipework insulation shall be applied in strict accordance with the manufacturers recommendations and BS 5970 : 2001.
- All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide adhesive foil tape to provide a permanent and continuous vapour-proof barrier over the insulation. All insulation terminations shall be sealed with tape to maintain the vapour barrier and a purpose made aluminium end cap to maintain a neat appearance.
- Security of sectional insulation shall be reinforced by additional 75mm wide aluminium foil tapes at 330mm centres.
- Bends, elbows, branch connections etc., shall be fully insulated with carefully site fabricated and mitred sections of pipework insulation finished with a neat and fully sealed covering of aluminium tape.
- Pipes or cylindrical vessels requiring to be insulated and having a diameter greater than 325mm, shall be insulated using slab material having closely scored 'V' slots in its inner face.

3.13.6 **Testing and Commissioning**

The Contractor shall thoroughly flush and then chlorinate the whole water system in accordance with HS(G)70 and BS6700 and as detailed below prior to completion and provide test certificates on completion to prove that the whole is in satisfactory condition. The works shall be carried out by a specialist contractor.

All hot water pipework shall be chlorinated from (and including) the point of connection to the water authority supply through to the point of supply.

Chlorination shall be carried out as follows:

- Clean and flush out to remove dirt and debris. No water is to be used for domestic purposes during this operation nor until chlorination is completed.
- Prepare the necessary quantity of disinfecting chemical to give a chlorine concentration of 50mg/litre. Follow the manufacturer's instructions.
- Chlorinate new mains or mains extensions first, followed by communication pipes, and supply pipes in that order.
- Add the prepared solution to the pipework, cistern/tank and draw through the system.
- Allow a contact time of one hour after the disinfecting chemical has been drawn through the system.
- Take a sample at the end of the time and check for residual chlorine with a comparator. If less than 30mg/litre is indicated, repeat the process until a residual is obtained.
- Thoroughly flush out to remove all traces of heavily chlorinated water.
- Discharge chlorination water as instructed by the Employer's Agent.

On completion of chlorination the Services Contractor shall provide analysis as follows:

- Take samples from a minimum of 10% draw off points after testing and chlorination.
- Dispatch samples to an approved testing laboratory for bacteriological and chemical analysis.

- Pay all charges for samples and analysis.
- Submit analysis result to the Engineer on receipt.
- Rectify any faults revealed by sample analysis which impair the quality of water beyond the limits set in the EC Directive on the quality of drinking water and pay all charges for re sampling/chlorination.

The water installation shall comply with the current recommendations of the Health and Safety Executive to reduce the risk of Legionellosis. A Legionella Risk Assessment shall be carried out in accordance with Hs (G) 70. The results shall be included in the operation and Records Manual.

3.13.7 **Testing and Commissioning**

As with all unvented units above 15 litres, it is a Building Regulation requirement that installers are competent to install calorifier units. (This normally means having successfully completed a course in unvented systems).

The whole of the hot water service shall be chlorinated and sterilised on completion of the works. A certificate shall be issued by the Contractor.

Legionella testing will be undertaken on the hot water supply on completion of the works.

The water installation shall comply with the current recommendations of the Health and Safety Executive to reduce the risk of Legionellosis. A Legionella Risk Assessment shall be carried out in accordance with Hs (G) 70. The results shall be included in the operation and Records Manual.

A schedule of water outlet temperatures shall be submitted as part of the O&M manuals.

Pipework is to be pressure tested to 1.5 times the working pressure. A record is to be made of the test pressure, time and duration of test.

3.14 Heating

3.14.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the heating services as follows.

Provide a new gas fired boiler, pumps etc as a complete primary heat source for:

- Underfloor heating to:
  - The Hall
  - Ladies toilets
  - Internal lobby
  - Foyer
  - Accessible WC
  - Office
  - Men's toilets
  - Meeting room
  - Kitchen
  - Store room

- LPHW heating coils fitted within the supply ventilation air streams on the kitchen supply fan and the main air handling unit.

3.14.2 **Standards and Guidance**

The systems shall be designed in accordance with the following standards:

- CIBSE Guide B
- BSRIA Guide AG16 2002 variable volume water systems
- BSRIA Guide AG14/99 variable speed pumping in heating and cooling systems
- CIBSE KS07 and KS09 variable volume water systems
- CIBSE Guide H
- Approved Document L2B and J
- BS EN 12828
- BS 5854
- BS 6880
- Clean Air Act Memorandum

3.14.3 **System Design Criteria**

External Ambient Design Conditions

Summer dry bulb temperature	-	30°C
Summer Humidity	-	50%
Winter dry bulb temperature	-	-5°C
Winter Humidity	-	50%

Internal Design Conditions

Areas with Heating

Hall and office	-	22 degrees
Ladies toilets	-	22 degrees
Internal Lobby	-	22 degrees
Foyer	-	22 degrees
Accessible WC	-	22 degrees
Men's toilets	-	22 degrees
Meeting room	-	22 degrees
Kitchen	-	22 degrees
Store room	-	22 degrees

Areas without Heating

Plant room

U Values/Heat losses/Cooling Calculations

Heat loss calculations shall be undertaken in accordance with CIBSE approved methods.

The Contractor shall be responsible for establishing the U values of each element of the building fabric by reference to construction details provided by the Architect/Main Contractor. For tender purposes these shall be based on the U values set out in Approved document L2A and an air tightness of 5m3/(m2.hr) at 50Pa.

All U values shall be verified by the contractor prior to commencement of the design.

Heat loss calculations shall be provided for any areas having heating. These shall take into account fabric losses, infiltration and mechanical ventilation rates, where specified, in addition heat transfer between rooms due to differing design temperatures or some being unheated shall being included.

The effect of insulation bridging by elements of the construction shall also be properly taken into account.

Heating systems must be capable of achieving design conditions irrespective of any heat gain within the space

Heaters shall be sized by the contractor to provide the design internal room temperature at minus 5 degrees C external temperature, within 20mins of turning system on from cold.

Infiltration rates	-	As recommended by C.I.B.S.E
Ventilation rates	-	As per the ventilation design

Design Velocities

Pipework velocities:

15 to 50mm no greater than 1.0 m/s
50 to 150mm no greater than 2.0m/s
NB: Minimum pipework size 15mm nominal bore

Design Pressure Drops

Heating Pipe work	-	Maximum 200 Pa/m
Gas	-	100 pa maximum pressure loss between Primary Gas meter and the furthest appliance

LTHW Heating Water Temperatures

The new heating system shall be designed to operate at flow and return temperatures of 80/60 respectively.

3.14.4 **System Description and Operation**

The primary heat source for heating shall be from 1no. Ideal EvoMax gas fired system boiler, or equal and approved. The heat output shall be a minimum of 40kW.

Boiler flue is to be provided by the Mechanical Sub-Contractor to suit the boiler location.

Primary heating distribution consists of a twin head shunt pump through the boiler unit connecting to a low loss header. Return pipework from the header connects back to the boilers with a cold feed (pressurisation) connection prior to the boiler return connection.

There shall be 1no. twin head pumped secondary circuit to provide LTHW to the air handling unit heater battery, the kitchen supply fan heater battery and the underfloor heating manifolds.

The boiler shall be fitted with a programmable timeclock and frost stat to control the heating.

The kitchen supply air heater battery three port control valve shall be controlled by the kitchen supply air fan controls (that being a temperature sensor fitted in the supply air stream).

The air handling unit heater battery three port control valve shall be controlled by the MVHR controls (that being a temperature sensor fitted in the supply air stream).

The underfloor heating manifolds shall be controlled by the underfloor heating controls (that being programmable room thermostat(s).

All sensors located within rooms shall be protected by caging to prevent damage once in use.

All heating pipework is to be thermally insulated. Pipework within plant rooms shall be protected with Aluzinc cladding.

The foyer area shall also have an electric door curtain manufactured by Thermoscreens to reduce draughts and heat losses from the space.

3.14.5 **Equipment and Materials Specification**

Boiler

Ideal boilers
National Avenue
Hull
East Yorkshire
HU5 4JB

Or equal and approved.

Flues

Suitable for use with condensing boilers (i.e. watertight).

Adequately supported

Incorporate a combustion test hole in each boiler primary flue section
base of vertical flue header to be installed with a condensate drain section.

Install in strict accordance with the manufacturers recommendations using proprietary locating spigots / flanges, V-bands, sealants, outer clamp bands etc.

Terminate with a suitable discharge terminal.

Heating Circulation Pumps

All heating circulation pumps are to be twin head and manufactured by Grundfos, or equal and approved.

Grundfos Pumps
Grovebury Road
Leighton Buzzard
Beds

LU7 4TL

01525850000

Pump sets to be wall mounted using unistrut support rails with Teco pads to minimise possible vibration transmission.

Each circulation pump installation shall incorporate flexible bellows (tied) together with all ancillaries, gauges, valves, test points, pressure differential switches etc.

The primary pumped heating circuit is to incorporate a pressure differential sensor (across flow and return) located in a strategic position within the circuit distribution pipework. The sensor is to be wired to the boiler controller.

The heating circulation pumps specified for installation are variable flow type and are to incorporate integral frequency converters.

Low Loss Header

The low loss header is to be welded heavy weight mild steel tubing with welded-on branch take-offs.

The low loss header is to be adequately supported level and plumb and is to incorporate the following features:

- Air vent connection
- Expansion / pressurisation unit system connection
- Welded branch connections with suitable isolators for every connection.
- Sludge collection pocket at bottom of low loss header with drain valve.

Pressurisation unit and expansion vessel

Provide and install 1 no. LTHW heating system pressurisation unit.

The aforementioned pressurisation system to comprise: -

- a Mikrofill Electronic Filling device (EFD)
- Mikrofill MikroPro expansion vessel(s).
- a 15mm MCWS supply with check valve and service valve, Stainless Steel braided flexible hose "quick fill" loop assembly (WRC listed fittings).
- a 25mm expansion pipe – connecting to low loss header
- the overflow connection off the EFD is to be routed by the Mechanical Sub-Contractor to discharge to drain (using uPVC solent welded pipework).

Above equipment to be installed in accordance with the manufacturer's instructions.

Mikrofill Systems Ltd
West Court, Merse Road
North Moons Moat, Redditch
B98 9HL
Tel: 03452 60 60 20

Or equal and approved.

Pipework and Fittings Specification

Above ground heating pipework	- Copper pipework with capillary soldered joints.
Underfloor heating pipework	- Multi layer composite pipe with HDPE (high density polyethylene) inner and outer layer.

Valves

Isolating valves on pipework insulated and shall be Peglar PB350EL, or equal approved.

Service isolation valves shall be fitted to every outlet and these shall be Peglar type CxUN Chrome, or equal approved.

Drain cocks are to be fitted to all low points to facilitate draining and these shall be Peglar type 833LS, or equal approved.

Equipment Supplier

Pegler Yorkshire Group LTD
Bellmont Works
St Catharines Avenue
Doncaster
DN4 8DF

01302 560560

Safety relief valves shall be as manufactured by Nabic, Fig 500; to be sized / selected to suit the boiler capacity, the system requirements.

Equipment Supplier

Nabic
46-48 Wilbury Way
Hitchin
Hertfordshire
SG4 0UD

Heater battery three port control valves – by fan supplier.

Underfloor heating three port control valves – by underfloor heating supplier.

Commissioning valve sets shall be provided to ensure sufficient water flow and balance. Commissioning sets to be manufactured by Crane, or equal and approved.

Equipment Supplier

Crane House
Epsilon Terrace
West Road
Ipswich
IP3 9FJ

01473 277300

Thermal Insulation

Rockwool Rocklap 800 mineral wool H & V pipe sections, having a nominal density not less than 120 kg/m3 with a factory applied facing which is a laminate of close mesh reinforcement between two layers of foil including integral lap for fixing. The whole to comply with BS5422 (Table 1) and BS5970 water vapour permeance and Building Regulations Class O definition. Thermal conductivity shall be not greater than 0.033 W/mK.

Pipework insulation shall be applied in strict accordance with the manufacturers recommendations and BS 5970 : 2001.

All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide adhesive foil tape to provide a permanent and continuous vapour-proof barrier over the insulation. All insulation terminations shall be sealed with tape to maintain the vapour barrier and a purpose made aluminium end cap to maintain a neat appearance.

Security of sectional insulation shall be reinforced by additional 75mm wide aluminium foil tapes at 330mm centres.

Bends, elbows, branch connections etc., shall be fully insulated with carefully site fabricated and mitred sections of pipework insulation finished with a neat and fully sealed covering of aluminium tape.

Pipes or cylindrical vessels requiring to be insulated and having a diameter greater than 325mm, shall be insulated using slab material having closely scored 'V' slots in its inner face.

Underfloor Heating

The mechanical contractor shall design, provide and install underfloor heating as specified on the strategy drawings. Underfloor heating to be controlled by individual room stats, controlling the temperature.

Underfloor heating to be provided by LuxusHeat, or equal and approved.

Equipment Supplier:
Luxusheat Ltd
20 William Street
Leicester
LE1 1RW

0116 251 4916

Door curtain

The mechanical contractor shall design, provide and install within the foyer area an electric over door air curtain.

The mechanical contractor will design, provide and install a manufacturers standard controls pack comprising a remote control plate housing on / off, speed high/low, heat off, low and high, suitable for fitting onto a standard two gang, recessed electrical back box.

Door heater controller to be located within the foyer area (final location to be agreed with the end users).

Door curtain to be manufactured by Thermoscreens Ltd;

Equipment Supplier:

Thermoscreens
St Marys Road
Nuneaton
Warwickshire
CV11 5AU

024 7638 4646

3.14.6 **Testing and Commissioning**

For the success of the pre-commission clean / dynamic flushing works, heating system flushing points of the correct size and in the correct locations is imperative.

The Mechanical Sub-Contractor (in conjunction with his Specialist Cleaning Contractor) shall determine the best locations (and size) for installing suitable flushing points (and to include for installing said).

Pressure Testing

The heating pipework shall be pressure tested to 1.5 times the final working pressure of the system. The mechanical contractor shall provide a certificate confirming success of this test with the O&M manuals.

Pipework Flushing and Cleaning

Following successful pipework pressure testing of the new heating system pipework, the Mechanical Sub-Contractor shall thoroughly flush and chemically clean the new heating system pipework installation in its entirety.

The newly installed heating pipework must be cleaned and chemically treated. A temporary pump set will be needed to circulate chemicals and achieve flushing velocities through the new heating circuits. The temporary pump set is to have surrounding protection barriers and is to be in a bund to assist with water collection in the event of a leak.

The pre-commission clean works are to be carried out by a Specialist Pre-commission Cleaning Contractor, employed by the Mechanical Sub-Contractor

The method to be adopted for carrying out the above works, through a process of flushing and chemical cleaning followed by the addition of biocides and inhibitors etc shall be in **strict accordance with BSRIA BG 29/2012 guidance document.**

The overall success of the system cleaning works is dependent on the thoroughness of each individual stage of the clean. In light of said, all BSRIA BG 29/2012 recommended sampling works, recording works, reporting works, documentation, inspections and witnessing of the cleaning process are to be conducted by the Mechanical Sub-Contractor (and his Specialist employed) as the work is in progress.

As a minimum (but refer to BSRIA AG 29 / 2012 for definitive requirements), to demonstrate the success of the system clean (separate for new and existing installations), the following will be expected: -

One week before pressure testing
Take samples from the flushing fill-water connection to the system. Test the samples for total viable counts (TVC), *Pseudomonas*, and sulphate reducing bacteria. Interpret the results (taking advice from a chemical cleaning specialist), recorded and reported.

One week before commencing of flushing and chemical cleaning
If the system contains water and has done so for a period of more than two weeks, then this water should be sampled and tested for TVC, *Pseudomonas* and sulphate-reducing bacteria levels. The results should again be interpreted (taking advice from a chemical cleaning specialist), recorded and reported.

During both flushing stages
Witness flushing velocities, and the cleanliness of strainers and dirt pockets in all parts of the system. A sample of any material extracted should be retained for future reference.

On immediate completion of the pre-chemical clean dynamic flush
Carry out:
A visual inspection of the water to confirm cleanliness
A soluble iron test. The soluble iron concentration of the system water must not exceed the recommended.

On completion of the chemical clean
Carry out:
A visual inspection of the pipework surfaces (by removal of a specially prepared, easily demountable section of pipe).

On completion of the chemical clean, and after the final fill and addition of corrosion inhibitors and biocides
Carry out:
Routine checks on strainers to ensure that particles collected are minimal.
Random sampling of the system water for chemical testing. Water should be taken from representative system extremities and low points. At an agreed position in the system, samples should be taken for record purposes, one to be kept by the Client, and one to be kept by the Cleaning Specialist. The results from all samples must lie within the BSRIA recommended limits.

Corrosion Inhibitor

Following the successful pressure testing of the new LTHW heating system and before any heat test is applied; the installations are to be dosed by the Mechanical Sub-Contractor with an Eco-friendly corrosion inhibitor (suitable for the various metals within the system)

Corrosion inhibitor concentration level to be in accordance with the Manufacturers recommendations calculated against the system water content.

Labels shall be attached to the dosing unit advising the presence of the inhibitor and the concentration to be used when refilling.

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

Boiler Commissioning

The boiler shall be commissioned by the manufacturer in accordance with CIBSE Commissioning Code B: Boilers. A manufacturers approved commissioning certificate shall be included within the O&M Manuals.

Over Door Heater Commissioning

The over door heater shall be commissioned by the manufacturer. A commissioning certificate shall be included within the O&M Manuals.

Seasonal Commissioning

The Mechanical Sub-Contractor shall allow for carrying out seasonal post contract commissioning (during a 12 month period), generally as follows:-

Testing of all building services under full load conditions, i.e. heating equipment in mid-winter, cooling/ventilation equipment in mid-summer, and under part load conditions (spring/autumn)
Where applicable, testing should also be carried out during periods of extreme (high or low) occupancy
Interviews with building occupants (where they are affected by the complex services) to identify problems or concerns regarding the effectiveness of the systems
Re-commissioning of systems (following any work needed to serve revised loads), and incorporating any revisions in operating procedures into the O&M manuals.

To comply with the above the Mechanical Sub-Contractor shall:-
Issue and work to a seasonal commissioning schedule/programme.
Provide evidence that the scope of the seasonal commissioning has been carried out (as evidence requirements 1 and 3 above).

3.15 Ventilation

3.15.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the ventilation services.

Supply and extract ventilation with heat recovery is to be provided to the following:

- The hall
- The meeting room

'Dirty' toilet extract ventilation is to be provided to the following:

- The ladies' toilets
- The accessible toilet
- The men's toilets

Dedicated supply and extract ventilation is to be provided (with dedicated controls) to the following:

- The kitchen

Supply only ventilation is to be provided to the following:

- Internal lobby

3.15.2 **Standards and Guidance**

The systems shall be designed in accordance with the following standards:

- CIBSE Guide B
- CIBSE Guide H
- Approved Document F
- Approved Document L2B
- HVCA DW144
- All relevant British Standards and Codes of Practice
- BSEN 14173 (Structural Adhesives)
- HSG 258 (Controlling Airborne Contaminants at Work)
- BS 5588 (Fire Safety)
- BS 7346 (Smoke Control)
- BS 9999 (Fire Safety)

3.15.3 **System Design Criteria**

External Ambient Design Conditions

Summer dry bulb temperature	-	30°C
Summer Humidity	-	50%
Winter dry bulb temperature	-	-5°C
Winter Humidity	-	50%

Internal Design Conditions

Areas with Heating

Hall and office	-	22 degrees
Ladies toilets	-	22 degrees
Internal Lobby	-	22 degrees
Foyer	-	22 degrees
Accessible WC	-	22 degrees
Men's toilets	-	22 degrees
Meeting room	-	22 degrees
Kitchen	-	22 degrees
Store room	-	22 degrees

Areas without Heating

Plant room

Ventilation Rates

Infiltration rates	-	As recommended by CIBSE
Hall	-	5 ACH
Kitchen	-	15 ACH (supply at 85% of extract)
Office	-	10l/sec/person
Meeting room	-	10l/sec/person

Ladies toilets	-	6l/sec/WC
Men's toilets	-	6l/sec/WC or Urinal
Accessible WC	-	6l/sec/WC

Design Pressure Drops and velocities

Ductwork	-	Maximum 1 Pa/m
Louvres	-	Maximum 2.0 m/s
Main Ducts	-	Maximum 6.0 m/s
Branch Duct	-	Maximum 4.0 m/s
Diffuser	-	Maximum 2.5 m/s
Kitchen Extract Main Ducts	-	Maximum 9.0 m/s
Kitchen Supply Main Ducts	-	Maximum 8.0 m/s
Kitchen Branch Extract	-	Maximum 7.0 m/s
Kitchen Supply Branch	-	Maximum 6.0 m/s
Gas	-	100 pa maximum pressure loss between Primary Gas meter and the furthest appliance

Aspect Ratio of ductwork not to exceed 3:1

Noise Levels

Type of Room	Upper Limit for the indoor ambient noise level (dB)
Hall	30
Office	30 (plus cross talk attenuators)
Meeting room	30

Indoor air quality

Hall

Concentration of CO_2 shall not exceed the maximum levels of 1,500 parts per million (ppm). Measurement and fan speed control to overcome CO2 build up shall be by room sensors monitoring CO_2 levels.

Cold draughts from incoming ventilation air in cold weather shall not cause thermal discomfort to occupants.

Kitchen

Concentration of CO2 shall not exceed 4500ppm within the kitchen.

U Values/Heat losses/Cooling Calculations

Heat loss calculations shall be based on the U-Values given in Approved document L2A 2013.

Heat loss and cooling calculations shall be undertaken in accordance with CIBSE approved methods.

The Contractor shall be responsible for establishing the U values of each element of the building fabric by reference to construction details provided by the Architect/Main Contractor.

All U values shall be verified by the contractor prior to commencement of the design.

Heat loss calculations shall be provided for any areas having heating. These shall take into account fabric losses, infiltration and mechanical ventilation rates, where specified, in addition heat transfer between rooms due to differing design temperatures or some being unheated shall being included.

The effect of insulation bridging by elements of the construction shall also be properly taken into account.

Heating systems must be capable of achieving design conditions irrespective of any heat gain within the space

Heaters shall be sized by the contractor to provide the design internal room temperature at minus 5 degrees C external temperature, within 20mins of turning system on from cold.

Infiltration rates	-	As recommended by C.I.B.S.E
Ventilation rates	-	As per the ventilation design

3.15.4 **System Description and Operation**

Air Handling Unit

1no. new Nuaire BPS-15 sectional air handling unit with plate heat recovery and heating coils shall supply tempered fresh air and extract stale air from the following spaces:

- The hall
- The office
- The meeting rooms

The air handling unit shall provide tempered supply air to the internal lobby which is make up air for the toilets. The toilet doors shall be fitted with intumescent door transfer grilles to permit this flow of air.

The air handling unit shall include an electric frost coil and LPHW heating coil to temper the supply air. Supply and control of the LPHW heating coil three port valves shall be by the air handling unit manufacturer.

The air handling unit shall be fitted with G4 pre-filter and F7 main supply grade panel filters.

The air handling unit shall be fitted into a plant deck above the meeting room. Access panels shall be provided to permit installation, maintenance and eventual removal of the air handling unit.

The air flow rates shall be boosted by signals from combined temperature and CO2 sensors located within each of the following spaces:

- The hall
- The office
- The meeting room

The temperature and CO2 sensors shall be protected by caging to prevent damage once in use.

The air handling unit shall receive an enable signal from a PIR located within the entrance foyer.

Kitchen supply and extract ventilation

1no. new supply fan with LPHW heating coil shall supply tempered fresh air to the kitchen. The dedicated fan controller shall control both the fan speed and the heater battery two port motorised control valve.

1no. new extract fan shall extract air from the kitchen. This shall be connected to the kitchen canopy.

The mechanical contractor shall design and provide a kitchen extract hood, ducted to the extract fan.

Toilet Extract Ventilation

Toilet extract ventilation shall be provided to each of the toilets.

1no. Nuaire Opus extract fan shall provide mechanical extract ventilation to the Ladies toilets.

1no. Nuaire Opus extract fan shall provide mechanical extract ventilation to the Men's and Accessible WC.

For all toilet extract ventilation, the system shall run in continuous trickle mode and be boosted by the lighting circuit. The toilet extract fans shall be provided with an integral timeclock and commissioned to 10 minutes run on,

3.15.5 **Equipment and Materials Specification**

Air Handling Unit Specification

The packaged supply and extract unit shall be manufactured from Aluzinc corrosion resistant steel, with 50mm double skinned panels and anodized aluminium frame. All external fittings and fixings shall be stainless steel, aluminium or non-metallic. All panels and frames will be of a totally thermally broken design, complying with the following specification in accordance with BS EN 1886: Mechanical strength, D1; Leakage class, L1; Thermal transmittance, T2; Thermal bridging, TB1. Panels and frames will be sealed without the use of silicon, mastic or other liquid gasket.

The unit shall include the following items:

- Plate HX: A high efficiency, ERP compliant heat exchanger with automatic bypass and power saving partial bypass, complete with a condensate tray and pump offering 20m of head pressure.

G4 pre-filter and F7 main supply filters shall be fitted with a single M5 bank present on the extract side. Slides for alternative panel and bag options shall be present and pressure drop monitoring for maintenance notification will be included.

Performance optimised backward curved impellers and IP54 EC motors shall be used to provide low specific fan powers and step less speed control without tonal noise generation. Fan pressure transducers shall be fitted (ES Connect & Adapt only) for

constant pressure/flow control and energy monitoring. Internal lighting and inspection portholes shall be present on all fan modules.

All hinged access panels shall be lockable and removable (with a common key for all) allowing full maintenance access from the side.

An LPHW heater battery shall be fitted.

A fail-safe auto-reset safety device shall be present.

Structural base frames shall be fitted, powder coated with covered forklift slots and 50mm square lifting bar holes for site manoeuvrability. Three axis alignment clamps shall be fitted externally.

An IP66/67 lockable isolator shall be present for power connection on main and electric heater modules.

Sealing grommets will be present for control cable access to the unit internals without the need for drilling on site.

Module electrical interconnection shall be made using pre-fitted plug and socket arrangements. Modules shall be provided with identification labelling to aid assembly and QR coded badges to simplify document retrieval via portable devices.

Equipment Supplier:

Nuaire Group
Western Industrial Estate
Caerphilly
CF83 1NA

Contact: Mike Waddington
Tel: 07767298202
Email: Mike.Waddington@nuaire.co.uk

Or equal and approved.

Kitchen Supply Fan

Provide a high-performance supply unit with LPHW coil and 2-port pressure independent valve.

Extended casing configuration 'A' with patented 'Floating fan' construction. Single skin, with infill panels and manufactured from heavy gauge, corrosion resistant Aluzinc steel. Units have integrated attenuation pods to reduce noise breakout.

Suitable for internal or external mounting and incorporating top or bottom access. The fan impeller and EC motors are selected to provide optimum performance and energy efficiency conforming to Part L regulations. Units are suitable for operation in ambient temperatures of up to 60°C (sizes 1-5) and 40°C (sizes 6-7). The unit is Class L2 leakage. The unit shall be controlled by a local control mounted externally to the case.

The fans shall have the following energy saving and operational functions integrally installed with in it, all components will be pre-wired and fitted by the manufacturer:
• Integral Frequency inverter/speed controller.

- Maximum and minimum speed adjustment/setting (trickle and boost).
- Volt free run & failure/status indication.
- Multiple low voltage sockets for interconnection of sensors or fans.
- Fitted with G4 filter..
- The Fan unit shall have a 5 year warranty

Equipment Supplier:

Nuaire Group
Western Industrial Estate
Caerphilly
CF83 1NA

Contact: Mike Waddington
Tel: 07767298202
Email: Mike.Waddington@nuaire.co.uk

Or equal and approved.

Kitchen Extract Canopy and Fan

Kitchen canopy shall be Induction hood complete with washable grease filters.

The hood shall be sized to cover the hob cooking area.

The hood shall be manufactured from easy to clean stainless steel.

The contractor shall supply install and commission kitchen extract fan, fire rated ducting, and all controls and ancillaries for a fully operational system compatible with the kitchen canopy.

Kitchen extract fan shall be a proprietary extract fan designed for kitchen extract, and temperature rated accordingly.

Supply ductwork shall be insulated.

Equipment Supplier:

Nuaire Group
Western Industrial Estate
Caerphilly
CF83 1NA

Contact: Mike Waddington
Tel: 07767298202
Email: Mike.Waddington@nuaire.co.uk

Toilet Extract Fan

The fans shall have low energy, high efficiency DC fan/motor assembly with sealed for life bearings, mounted within an acoustically lined, 100% recyclable plastic case, ensuring a very efficient quiet solution.

It shall have noise levels and power requirements as detailed in the specification and in accordance with the manufacturers details. The unit shall incorporate a quick release mounting bracket. The bracket shall enable the unit to be mounted horizontally or vertically, enabling the unit to be removed without the aid of specialist tools. The unit shall be constructed with one removable panel allowing quick and easy access to the electrical connections. For commissioning purposes, the unit shall have a miniature control panel mounted in its facia facilitating high and low speed adjustment (trickle and boost) together with run on timer (1- 60minutes) and shall be accessible without the need of removing any access panels or the unit itself. Any adjustments shall be quickly and easily achieved with a standard screwdriver. The control panel shall also have status indication lamps on the underside of the unit.

Equipment Supplier:

Nuaire Group
Western Industrial Estate
Caerphilly
CF83 1NA

Contact: Mike Waddington
Tel: 07767298202
Email: Mike.Waddington@nuaire.co.uk

Or equal and approved.

Supply diffusers

Diffusers to be manufactured by Gilberts complete with manufacturers side entry plenum boxes and iris damper within spigot connection. Plenum boxes to be as shallow as practically possible and to incorporate manufacturer's integral air flow equalising plates to suit diffuser.

Swirl diffuser plenums to be independently supported off the structured slab / building structure (i.e. weight of grille / plenum not to be borne by the ceiling system).

To be selected to meet the noise criteria stipulated above, under 'Background Noise Levels'

All diffusers to be colour finished to match the architectural finishes (the swirl diffuser integral adjustable blades to be black).

Equipment Supplier:

Gilberts (Blackpool) Ltd
Gilair Works, Clifton Road
Blackpool, Lancashire. FY4 4QT
Tel: 01253 766911
Fax: 01253 767941

Extract grilles

All suspended ceiling mounted extract air grilles shall be: -

- Perforated face type grilles as manufactured by Gilberts type PE.

- To be attractively styled comprising of a perforated, 50% free area, steel fascia fixed in a 32mm aluminium flange border frame.

- To be complete with a rear mounted opposed blade volume control damper (screwdriver operated through face of grille).

- Grilles to have a polyester powder coat finish-colour to suit the architectural finishes.

- Grilles to have grille plenum boxes (painted internally black).

- Grilles to be independently supported so no weight is borne by the ceiling system.

- To meet the noise criteria stipulated above, under 'Background Noise Levels'.

Mechanical Sub-Contractor to provide suitable plenum boxes

Equipment Supplier:

Gilberts (Blackpool) Ltd
Gilair Works, Clifton Road
Blackpool, Lancashire. FY4 4QT
Tel: 01253 766911
Fax: 01253 767941

Door transfer grilles

Provide and install air transfer grilles for toilet area extract system make up air

Said transfer grilles to be two part quality grilles (pressed steel / pressed aluminium grilles are not to be used) with chevron non-vision grille blades (minimum of two per grille).

Colour finished to match the architectural finishes.

Fire rating to match the fire strategy. For tender purposes, allow for sixty minutes.

Equipment Supplier:

Gilberts (Blackpool) Ltd
Gilair Works, Clifton Road
Blackpool, Lancashire. FY4 4QT
Tel: 01253 766911
Fax: 01253 767941

Attenuators

Provide and install duct attenuators generally as shown on the drawings.

Silencer casings shall be fabricated from Grade Z2 pre-galvanised steel sheet, utilising Pittsburgh lock seam and grooved seam joints as appropriate. Each joint shall be filled with high velocity duct sealant conforming to HVAC DW144 Specification, irrespective of Leakage Class called for.

The attenuator flanges shall be secured to the casing via mechanically closed, sealed blind rivets having a shear strength of 2260N/m, at maximum pitches of 225mm. Rolled steel flanges shall have the casing end returned over its face regardless of the specified Leakage Class.

All attenuators are to be manufactured using proprietary flanges which are to have additional sealant applied between corner pieces irrespective of the specified Leakage Class.

Attenuators shall have internal sideliner and splitter elements which are to be constructed from Grade Z2 pre-galvanised perforated steel sheet, having a free area of not less than 37% which is to be formed into trays. These trays shall be linked together using pre-fabricated angles to form a self-contained unit.

The attenuators media utilised shall be 32kg/m^3 density "Super Glass", which shall be additionally faced with a woven glass fibre scrim to prevent fibre erosion into the air stream. "Super Glass" to be completely inert and not harbour bacteriological growth and to be tested in accordance with BS476 parts 4, 6 and 7.

All silencer sideliner and splitter elements shall be fitted with leading and trailing radiused fairings which are to be formed from Grade Z2 pre-galvanised steel. Splitter elements shall be secured into the silencer casing via two parallel rows of sealed rivets at a maximum pitch of 250mm.

High pressure sealant shall be universally applied to all joints between internal sideliner and splitter elements and the casing.

Equipment Supplier:

CAICE Acoustic Air Movement Ltd
Riverside House
3 Winnersh Fields
Wokingham
RG41 5QS
Tel: 0844 8475370

Fire Dampers

Provide and install duct mounted fire dampers within all fire compartmentation walls.

Fire dampers to be LPCB approved.

All fire dampers shall be as manufactured by Trox, or equal and approved and installed in accordance with the fire strategy plans and reports plus any wall/floor penetration that are designated as a fire partition.

The dampers shall be resettable fusible link – thermally actuated at 72degC and manufactured to comply with EU Regulation 305/2011/EEC and BS EN 15650.

Ductwork

All duct work shall generally be spiral wound. Duct work is to be installed in accordance with all relevant guidelines, in particular DW144 with regards to installation, support bracketry, sealing etc. All ductwork shall have appropriately positioned access doors for general cleaning and maintenance, again in accordance with DW144.

All ductwork systems are to be low pressure Class A.

The following supply and extract ductwork shall be thermally insulated.

- All fresh air intake ductwork.
- All AHU ventilation supply air ductwork and return air ductwork and discharge air ductwork to atmosphere (and any associated attenuators).
- All new ductwork shall have direction of flow and service description indication labels applied throughout.

External Louvres

Provide and install external louvres for air exhaust purposes generally as shown on the drawings.

Louvres to be continuous line appearance as manufactured by Gilberts (Blackpool) Ltd type WGF/38/BG.

Louvres to be manufactured from extruded aluminium with fixed blades and fixing flange and to be complete with bird guard.

Louvres to be Polyester Powder Coated to a colour to be confirmed.

All louvres shall be fitted square and level within the walls.

Forming of holes through the building envelope to accommodate louvres is to be carried out by the Principal Contractor. All building penetrations to be fully sealed around newly installed services.

Equipment Supplier:

Gilberts (Blackpool) Ltd
Gilair Works, Clifton Road
Blackpool, Lancashire. FY4 4QT
Tel: 01253 766911
Fax: 01253 767941

3.15.6 **Testing and Commissioning**

All ventilation systems shall be commissioned in accordance with CIBSE commissioning code A: Air distribution systems.

The Mechanical Sub-Contractor shall ensure all engineering services systems are thoroughly commissioned and tested to prove that they are capable of achieving the specified performance, to prove the correct and stable operation of all control systems and are safe to operate and maintain.

The Mechanical Contractor shall provide all equipment, labour and material to ensure that all services provided by this contract are fully tested and commissioned in accordance with Materials and Workmanship Specification and requirements herein to ensure that they are operating correctly and efficiently.

A specialist commissioning engineer, not directly employed by the Mechanical Contractor, shall carry out all commissioning work.

The Mechanical Contractor shall provide typewritten certification of results on the completion of tests which shall be signed as witnessed and accepted by the Contract Administrator or his representative.

Certain items of work must be inspected and certified by an independent body. The Mechanical Contractor is required to employ the independent specialist and pay all costs involved.

The Mechanical Contractor shall be responsible for all costs involved.

Commissioning of the following services shall be carried out:

All ventilation systems

The commissioning process will consist of six distinct stages:

- Physical inspection and static checks
- Setting to work
- Initial performance tests
- Regulation and balancing
- Final checks
- Recording of test data and set points

Initial setting to work must be carried out prior to inspection by the Engineer or his representative. When final settings have been made then they will need to be witnessed by the Engineer or his representative.

The Mechanical Contractor is to provide three typewritten copies of all test results, control settings and set points. Records must show details of the test carried out and must uniquely identify the plant and/or area referred to.

Test results must be properly bound in a hardback binder and must be signed as witnessed by the Engineer or his representative.

Specific Requirements

The Mechanical Contractor shall inspect the operation of all plant and must ensure that plant is running at optimum efficiency and that design temperatures and flow rates are achieved.

The Mechanical Contractor shall make all necessary adjustments to controls and regulating devices to obtain these requirements.

Inspection and Static Tests

The Mechanical Contractor shall carry out a full inspection of the plant and equipment provided.

This will require the production and completion of pre-commissioning test sheets for all items of equipment. The Mechanical Contractor is to compile all necessary lists and is to provide the Engineer or his representative with copies for approval before inspection starts.

The Mechanical Contractor shall inspect all plant, equipment, ductwork, pipework and associated controls, fixtures and fittings. He shall verify that the installation is complete and has been installed correctly.

It is the responsibility of the Mechanical Contractor to rectify defects noted.

Setting to Work and Initial Tests

On completion of pre-commissioning inspections, the Mechanical Contractor is to set to work all items of plant. This must not be done until approval is given by the Engineer or his representatives. The Engineer's approval will not be given until the Mechanical Contractor has recorded that he is satisfied that the installation is complete and satisfactory.

The commissioning engineer is to inspect and adjust the operation of all plant to ensure that it is operating at optimum efficiency.

Regulation, Balancing and Final Check

The commissioning engineer is to regulate and balance all water and air flow rates and control settings necessary to provide fully balanced systems at the design flow rates and design temperatures. Balancing is to be carried out fully in accordance with CIBSE/BSRIA codes of practice.

On completion of balancing and regulation the commissioning engineer shall check that the final flow settings are correct. These shall be demonstrated to the Engineer or his representative.

Recording of Data

The commissioning engineer is to keep formal records of each stage of the commissioning procedure. These records are to be typewritten and submitted to the Engineer for inspection prior to handover.

The commissioning engineer is to formally record all test records, inspection results, flow rates, temperatures and control settings for inspection and approval by the Engineer or his representative. The Engineer must witness final settings before the installation will be accepted.

The commissioning engineer shall record data on a combination of their own test sheets subject to final agreement with the Engineer with regard to recordability of all necessary readings.

Independent Testing

The Mechanical Contractor shall be wholly responsible for the costs of organising and employing an independent insurance inspector or specialist to carry out testing described within this section.

In addition, the Mechanical Contractor shall be responsible for rectification of any defects notes, the implementation of any recommendations and subsequent re-testing. The Mechanical Contractor shall pay all costs involved.

The following tests shall be carried out by an insurance inspector (Ajax, British Engine):

Insurance testing of pressure vessel.
Insurance testing of lifting beams and equipment.

The following tests shall be carried out by an independent specialist:

Certification of hot and cold water chlorination

Instrumentation

The Mechanical Contractor is to provide the following equipment for use by the Engineer:

- The equipment must be made available two weeks before completion of any item of mechanical 2nd fix and before any plant is commissioned or operate.
- Instruments must remain in the safe keeping of the site staff on the understanding that they will not be removed from site. The Mechanical Contractor is to provide a lockable cabinet for this purpose.
- Instruments will be returned to the Mechanical Contractor on final handover of the buildings to the building user.

Instruments must be supplied complete with valid calibration certificates as agreed with the Engineer from the following list for commissioning purposes, at no extra cost to the tender price:

- Whirling hygrometer (sling) with a supply of distilled or de-ionised water.
- Digital electronic temperature instrument with insertion probes suitable for use with the test points installed by the Contractor
- Hot wire anemometer
- Rotating vane anemometer
- Manometer (air with pitot static tubes)
- Manometer (mercury and water)
- Smoke tubes with bellows
- Thermohygrographs with spare recording sheets
- Mercury in glass thermometer
- Sound level meter with octave band filter
- Earth loop impedance tester
- Clip on ammeter 0-1000A AC
- Digital multi meter

Labelling

All valves and equipment shall be labelled in accordance with the Materials and Workmanship Specification. Including the provision of valve charts, schematics, isometrics, etc.

Labels on electrical isolators serving items of equipment shall use the same terminology as the main equipment label.

Testing, Commissioning and Operating & Maintenance Records

Upon completion of each phase of the works, prior to Practical Completion, all services will be tested and commissioned in accordance with the recommendations of the IEE and BSRIA and set to work. As-built drawings of all services will be kept by the Site Manager in his office along with comprehensive Operating and Maintenance Manuals prepared in accordance with BSRIA application guide AG 1/87.

3.16 Above ground drainage

3.16.1 Scope of works

The Mechanical Contractor shall allow for the design, supply, installation, testing and commissioning of the above ground drainage services to:

- The Ladies toilets
- The Accessible WC
- The Men's toilets
- The Kitchen
- The plant room
- MVHR condense
- Boiler flue condensate and safety relief let off

The Mechanical Contractor shall liaise with the below ground drainage specialist to ensure all required drainage points are connected to the below ground drainage system.

The Mechanical Contractor shall allow to install any sanitary ware that is to be provided by the Main Contractor.

3.16.2 System Description and Operation

A gravity assisted above ground drainage system shall discharge waste from the areas identified in the scope of works to the below ground drainage.

3.16.3 Standards and Guidance

Above ground drainage pipe work is to be suitable sized in accordance with BS EN 12056 recommendations.

3.16.4 System Design Criteria

Above ground drainage pipe work is to be suitable sized in accordance with BS EN 12056 recommendations.

From the below ground drainage drawing the Mechanical Contractor shall ascertain the furthest soil stack connection which is to be ventilated through the roof, all other soil stacks are to terminate a minimum of 1500mm AFFL with an automatic air valve.

3.16.5 Equipment and Materials Specification

Pipework and Fittings Specification

All pipes and fittings shall be un-plasticised polyvinyl chloride uPVC and shall be solvent weld jointed. The jointing procedure shall be strictly in accordance with the manufacturer's sequence of requirements. Joints between the uPVC and the underground drainage system shall be made using a suitable drain adaptor. Traps to lavatory basins, sinks, urinals shall have a 75mm seal, re-sealing bottle with detachable base made from high density polyethylene. Traps to wash hand basins shall have a 50mm deep seal integral trap.

Testing and Commissioning

All above ground drainage and vent pipes within the building shall be tested as specified to the satisfaction of the supervising local authority representative. Testing shall be carried out after the main stacks have been fixed in position and all branching pipe work installed. It is the responsibility of the contractor to notify the supervising officer when the installation is ready for testing.

Upon completion of the contract, the entire installation shall be thoroughly flushed with clean water.

4.0 ELECTRICAL GENERAL MATERIAL AND WORKMANSHIP CLAUSES

All electrical installation works, including design, construction, inspection and testing and commissioning shall only be carried out by a Contractor competent to carry out such works as described in the Particular and General Electrical Specifications and shown on the drawings. The Contractor shall provide adequate fully trained, competent electrical operatives for the works, to undertake and construct the works safely and in accordance with the requirements of the programme.

In the specification the Electrical Contractor shall hereinafter be referred to as the contractor. It is a matter of contractual arrangement on any works how the parties shall be identified and "Contractor" may need to be reinterpreted accordingly. The "Engineer" shall be the person, persons or company supervising the works on behalf of the owner or Client and likewise this shall be interpreted accordingly in any agreements.

4.1 General Workmanship

All works carried out by the contractor shall be of a high standard and shall enable the systems to be complete and to function in the most effective manner. The Particular Specification accompanying this specification shall override any conflicting requirements with the General or Workmanship specifications.

All materials, products and workmanship shall comply with all current British legislation and regulations; which include, but are not limited to, the following:

- Government Rules and Building Regulations
- BS 7671 Requirements for Electrical Installations
- Safety and Health at Work Act and Regulations made under this Act
- Public Health Acts
- Control of Pollution Acts
- Local Authority Byelaws and Regulations
- Control of Substances Hazardous to Health Regulations
- Asbestos Regulations
- The Electricity Supply Regulations
- British Standards
- Water Supply Authority Regulations and Requirements
- Gas Supply Authority Requirements and Safety Regulations
- Electricity Supply Authority Requirements and Regulations
- Loss Prevention Council rules
- LDSA Fire, Safety Guide
- National Telecommunications Regulations

The Contractor shall provide attendance for and inspection in connection with all the above, and shall liaise with the Building Inspector, Environmental Health Officer, Highway Engineer, Medical Officer, Refuse Engineer, Fire Officer etc., as necessary or ensure their satisfaction with the works.

The Contractor shall pay all charges made by any authority in approving any part of the works, and shall notify the Engineer of any revisions or additions to the above publications which occur during the installation of the works.

4.2 **Materials**

Where certificates are furnished by the manufacturer stating that the materials comply in all respects with a relevant standard, the Contractor shall obtain and forward same to the Engineer. Any changes arising from these requirements are to be included in the tender sum.

Commodities specified to conform to British Standards shall be clearly indelibly marked with the reference specified. Where this is impractical the relevant advice and delivery notes shall include the BS reference with which they comply.

Where commodities are specified as manufactured by a BSI Kitemark Licensee or where commodities/services are specified to be by Registered Firms (under BSI Assessment Schemes) the manufacturer/firm must be a current participant in the relevant scheme.

Where commodities or systems are specified as certified by the British Board of Agreement the commodities or systems supplied shall be subject to a current BBA certificates.

Where commodities or services are specified to be registered/approved firms, under Approved Quality Assurance Schemes, the manufacturer/firm must be a current participant in the relevant scheme.

The equipment and/or installation shall conform to the relevant British Standards and Codes of Practice current three months prior to the date for return of tenders, unless indicated otherwise. Certificates of compliance shall be provided to the engineer at his request.

Generally with reference to the quality of materials the tender prices shall be deemed to include the following requirements:

- Where and to the extent that materials, products and workmanship are not fully specified they should be:

1. Suitable for the purposes of the works stated in or reasonably inferred from the Contract specifications and/or drawings.

2. In accordance with good building practice, including the relevant provisions of current BS Specifications and/or documents.

- Where approval of products or materials is specified samples or other evidence of suitability are to be provided. Orders for materials are not to be confirmed until approval has been given by the Engineer. Approved samples are to be retained on site for comparison with products and materials used in the works and finally removed when no longer required.

- Where samples of finished work are specified approval of stated characteristics shall be obtained before the works are proceeded with.

- Samples, which are not part of the finished work, shall be removed on completion.

- Where and to the extent that products, materials and work are specified "To be Approved" or the Engineer instructs or requires that they are to be approved, the

same must be supplied and executed to comply with all other requirements and in respect of the stated or implied characteristic(s) either.

3. To the express approval of the engineer
   or
4. To match a sample expressly approved by the Engineer as a standard for the purpose.

- Inspection or any other action taken by the Engineer must not be taken as approval of materials, product or works, unless the Engineer confirms in writing, in express terms, referring to:

5. Date of inspection.
6. Part of the works inspected.
7. Respects of characteristic(s), which are approved.
8. Extent and purpose of the approval.
9. Any associated conditions.
10. Materials are to be suitable for the climatic conditions in the area in which the project is located.

Where necessary all materials or equipment shall comply with the relevant standards necessary to comply with necessary European Directives implemented in UK legislation. The materials or equipment shall be properly and clearly "CE" marked.

Materials and equipment not manufactured in the U.K shall require evidence of compliance with British Standards by tests carried out by a recognised authority. Spares and replacement parts shall be obtainable in the country of installation.

All equipment delivered to site shall be clearly marked with the manufacturer's name, brand name, or any other data that may be required to verify the exact nature of the equipment or materials, and relate it to the requirements of the specification. Where necessary the required CE marking shall be clearly visible.

The Engineer may request, throughout the duration of the project, samples of components and materials the Contractor proposes to use. These must be supplied as required by this specification at the Contractors cost.

Samples shall be identical in all respects with the material that it is proposed to include in the works and shall be of adequate size or quantity to permit proper evaluation and review. Relevant manufacturer's literature shall accompany all samples.

Any work carried out prior to samples being submitted and approved in writing shall be at the Contractors risk. Any material not approved shall be removed and replaced at the Contractors cost.

4.3 Site Operations

4.3.1 Fire Precautions

All necessary precautions shall be taken to prevent any outbreak of fire.
This shall include where site welding is carried out where the Contractor shall take all necessary precautions to prevent fire damage to inflammable building materials.

All cables, ducts and pipes shall be sealed in accordance with relevant regulations where they pass through floors, structural walls and fire barriers.

Any flammable solvents, paint, gases or other fluids shall be stored in a purpose made external enclosure displaying the statutory notices.

4.3.2 **Control of Electrical Equipment**

During the construction works the Contractor shall be responsible for full control of all electrical systems and equipment within the work area and for all switching operations associated with the works. When not required, isolators shall be locked in the "OFF" position.

4.3.3 **Oil and Grease**

All necessary oils and grease shall be supplied by the Contractor for the first filling of starters, wells in bearings etc. All shall then be kept topped up as necessary for all commissioning procedures and up to practical completion.

4.3.4 **Fuel**

The Contractor shall provide all necessary fuel for the site testing commissioning and subsequent filling full of the fuel tanks for all necessary equipment such as generators, engines etc.

4.3.5 **Keys**

Unless specifically stated to the contrary elsewhere in this Contract, the Contractor shall supply three keys and spanners of each size for all key operated equipment and enclosures supplied under this contract. All tools and keys shall be suitably identified and handed to the Engineer at completion of works.

4.3.6 **Satisfactory Appearance**

The complete installation shall be of a neat appearance and to the satisfaction of the Engineer. Any installation or part thereof not approved as such shall be removed and re-fitted at the Contractors cost. All cable, conduit, trunking routes etc. shall be square with the building and follow the building line unless agreed otherwise in writing with the Engineer.

4.3.7 **Notice to Cover**

The Contractor shall give seven days' notice of intention to cover any services. Failure to do so shall require his uncovering and recovering such services, if required by the Engineer for inspection or any other reason, at the Contractors cost.

4.4 **Suppression**

All electrical plant and equipment shall have necessary suppression equipment to prevent any interference with radio, television, telephone and security systems, and comply with the EMC Regulations.

4.5 **Regulating and Performance Tests**

Upon completion of works the Contractor shall, when required by the engineer demonstrate the ability of any section of the plant or its components to function as required by the specification.

All equipment shall be supplied and all works carried out with due regard being given to their inspection, cleaning, repair and future maintenance or extension.

The metric system of measurement units shall be used throughout for the detailing and manufacturing of equipment and for the setting out of the works. Where equipment or parts thereof can only be supplied in imperial sizes, the Engineer shall be informed prior to order.

All items of equipment shall be adequately ventilated, using mechanical means if necessary, to dispel any heat produced or dust or fumes generated by the equipment. The Contractor shall be responsible for ensuring that maximum ambient operating temperatures or conditions are obtained from the manufacturer, where these are not defined in the particular specification, and that this information is passed on to the Engineer prior to order.

For each item of equipment the Contractor shall obtain general arrangement drawings, constructional details, fixing or mounting information, electrical schematic diagrams and wiring diagrams as appropriate. These shall be in accordance with good drawing office practice and shall use symbols described in BSEN60617. Each drawing shall give a full description of the equipment, a drawing title, a particular reference for the item of equipment and the Manufacturer's name and details.

Where equipment is provided with a guarantee by the Manufacturer, the Contractor shall ensure that the benefits of the guarantee are enjoyed by the client for the full period, commencing from the date of handover. Where a Manufacturer offers an improved or amended guarantee particular to a specific project, this shall be brought to the attention of the Engineer. Where the terms of any guarantee offered by a Manufacturer in any way seek to alter the Statutory Rights of the Client, this shall also be brought to the attention of the Engineer.

Materials used in the manufacture of equipment shall not include:

- Asbestos, in any form.
- Polychlorinated Biphenyl.
- Radioactive substances (unless called for in the particular specification).
- Wherever possible, any material or substance not classified as non-combustible or self-extinguishing.
- Wherever possible, plastics other than those with low smoke and zero halogen gas emission during combustion.
- Rubber (unless called for in the particular specification).
- Any substance known to be a pollutant to the environment.
- Any CFC or CFC-blown based material.

All potentially dangerous equipment shall have fully adequate safety signs, externally and internally, to impart prohibition, warning, mandatory and safe working instructions as necessary. These shall be in accordance with BS 5378.

4.6 Pre-Ordered Equipment

Where equipment has been pre-ordered, prior to tender, in order to expedite delivery on programme, it is the sole responsibility of the Contractor who places the actual order, to ensure that such plant or equipment conforms in every detail to all relevant clauses of the specification.

4.7 Electrical Power Supply

A low voltage supply is preferred wherever this can be provided by the Supply Authority. Where a high voltage supply is necessary, this shall be fully discussed and agreed with the Engineer.

All low voltage supplies shall preferably have a TN-S arrangement but a TN-C-S arrangement shall be acceptable where this is provided as standard by the Supply Authority. The supply shall have declared parameters of 400/230 volts (+10%-6%) with earthed neutral, 3-phase, 4-wire 50 Hertz alternating current. For both the TN-S and the TN-C-S supply arrangements a separate main earthing terminal shall be provided to which the Contractor shall arrange for all services to be main bonded. In the case of the TN-C-S supply arrangement the contractor shall ensure that any declaration required by the Supply Authority is made in respect of the bonding.

Negotiations with the Supply Authority shall generally be carried out by the Engineer. Where they are to be carried out by the Contractor however they shall be in accordance, where relevant, with the following procedures:

4.7.1 Estimation of maximum demand

Estimations for initial design purposes shall be carried out by the Engineer. In all cases before any approach is made to the Supply Authority the Contractor shall discuss and agree the design requirements with the Engineer. An allowance must always be included of an estimation of the future growth for the premises.

4.7.2 Point of supply and metering

For a low voltage supply the point of supply, and metering, shall preferably be at the main low voltage switchroom. Where the point of supply is remote from the low voltage switchroom, or a sub-station is required, the metering location shall be carefully considered and a suitable location chosen to be accessible at all reasonable times to the Supply Authority. The location shall be protected against tampering, mechanical damage, or vandalism, especially where the metering is accessible from the exterior of the building. Where the Supply Authority have a standard exterior metering enclosure this shall be used wherever possible for exterior metering.

The metering shall not be incorporated into the main low-voltage switchboard.

4.7.3 Supply balance

The Contractor shall take every care to ensure that the load attached to the Supply Authority terminals is reasonably balanced between the phases at all times. Phase balance at the point of supply is most essential when bulk or supplementary bulk power factor correction is applied to ensure correct operation of the sensing relay and switching of the correct amount of capacitance.

4.7.4 Power factor correction

The Contractor shall ensure that the power factor of the load applied to the Supply Authority terminals is that which provides the most favourable tariff. Where power factor correction (PFC) is required, it shall be by the use of bulk correction at the point of supply. A fully automatic system shall be installed, using multi-stage capacitor banks, with each step no greater than 50 kVAr. The capacitors shall be controlled by a

suitable multi-stage, purpose built, PFC relay. The complete PFC system is to be housed in a purpose made enclosure adjacent to the main switch panel.

In certain circumstances the Engineer may sanction the use of remote direct-on-line PFC units, for example to large motive loads. The Contractor shall, in this event, obtain the approval of the Engineer.

The Contractor shall ensure that all PFC substances used are non-carcinogenic and non-toxic. The use of PCB substances is totally prohibited.

4.7.5 **Earthing:**

Where the supply Authority does not provide an earth terminal the Contractor shall design and install a suitable earth terminal to comply with the requirements of the Electricity Supply Regulations and BS 7671 and to the approval of the Engineer.

4.8 **Suitability of Materials and Products**

All equipment shall preferably be designed and manufactured to a Quality Assurance scheme assessed to meet the requirements of BS 5750 or ISO 9000. The Contractor shall bring to the attention of the Engineer any equipment not subject to such a scheme.

All materials shall be new and of types and qualities described, at least equal to approved samples.

As soon as practicable after receiving the order to commence the works the Contractor shall confirm to the Engineer the names of suppliers from whom he proposes to obtain any materials, but he shall not place any order without approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination. Any materials, which in the opinion of the Engineer do not meet these requirements shall be removed from site and replaced at the Contractors expense.

Materials and products shall be supplied to suit the temperatures and other conditions normally expected during transit, storage, installation and use, and also to withstand any test specified in the contract documents.

The general atmospheric conditions under which Equipment will be required to work may be polluted with industrial fumes or salt air and care shall be taken in the selection, and installation of Equipment to prevent long term deterioration due to these conditions.

Equipment shall be fully capable of withstanding variations of temperature arising under working conditions without distortion or deterioration, or the setting up of detrimental stress in any part, and also without affecting the suitability of the various parts with which they have to perform.

Unless otherwise stated all Equipment shall be capable of operation in humidity conditions of 50% R.H. at 30 Centigrade indoors. Equipment for use outdoors shall be capable of operating at 100% R.H. at 40 Centigrade.

The Contractor shall check the altitude in every area and shall ensure that all Equipment selected is capable of operation without deterioration at the prevailing altitude (generally less than 100m).

Equipment intended for use outdoors shall not be subject to deterioration due to ultra violet radiation.

Equipment shall not, as far as possible, offer a source of oxygen or other biogenic elements to micro-organisms. The presence of anaerobic earth bacteria, mould fungus or enzymes shall not result in the degradation of material. The equipment shall not contain materials or compounds that offer sustenance or attraction to vermin.

Equipment using or containing water shall be designed so as to prevent the breeding of Legionella bacteria. Wherever necessary water shall be treated chemically for the suppression of Legionella bacteria.

4.9 **Finishes**

Generally, the finish and colour normally applied to the equipment by the Manufacturer shall be used. Where a choice exists and no specific finish is stated in the particular specification, it shall be the responsibility of the Contractor to select the most appropriate finish to suit the application. Where it is necessary for aesthetic or other reasons, for a special colour or finish to be used this shall be detailed in the particular specification. The Contractor shall provide the Engineer with full details of the proposed finish for each item of equipment prior to ordering.

From time to time special situations may occur which cannot be accommodated within the normal paint or galvanised finishes commonly used for Equipment. In these instances special finishes may be required, for example, extra thick galvanised finish, stainless steel finish, special plated finish, etc. The Contractor shall assess each of these special situations on its merits and propose a suitable solution to meet the requirements of the situation.

Wherever the Contractor uses Equipment having a galvanised finish this shall be of a type that is galvanised after all manufacturing operations have been completed. The galvanising process used shall conform to, and provide the deposit thickness detailed in BS 729. Where galvanised Equipment is subject to cutting, drilling, or other operations during installation the Contractor shall ensure that it is either re-galvanised or provided with some other local finish to provide equivalent protection.

Machined surfaces that are to be left bright after installation shall be suitably protected against detriment by means of an application of suitable grease, liquid film, etc.

Where Equipment is purpose made for a particular installation it shall be provided with a finish suitable to the location. This finish shall preferably be applied at the place of manufacture and shall be applied to all faces of the Equipment before installation. The practice of installing Equipment and then painting, leaving faces wholly or partially unprotected, is not acceptable.

4.10 **Equipment Protection**

The Contractor shall provide adequate and safe storage and protection for all materials, plant and equipment provided in this contract. All equipment shall be stored in accordance with the relevant British Standards advice.

All conduit is to be stored on purpose made racking giving adequate support to prevent bending and distortion. End caps will be used to protect conduit ends at all times prior to installation. Storage of conduits by laying on the ground will not be permitted.

All plant and equipment shall be so stored as to protect them from damage due to building work, and covered as appropriate.

Any machined or bright surfaces shall be protected by paint, tallow or grease if this has not been carried out by others or has been removed during transit. Upon completion surfaces so coated shall be cleaned and where applicable polished. Corrodible items shall be painted immediately after removal of the temporary protection.

The Contractor shall select, install or provide protection to equipment such that it is unaffected by the following conditions which can reasonably be foreseen for the equipment throughout the design life of the installation, taking into account any details set out in the particular specification.

4.10.1 **Frost**

Where Equipment is located outdoors, or indoors in unheated enclosures, or enclosures open to the atmosphere for ventilation, it may be subjected to damage, deterioration, or reduced performance due to frost deposits and the Contractor shall assess the risk in every case and select Equipment either designed to operate in such conditions or provided with suitable protection to prevent damage, deterioration, or reduced performance of the Equipment. When assessing the frost potential of any location the Contractor shall consider its exposure and associated wind chill effect.

4.10.2 **Condensation**

Where Equipment is subjected to temperature differences and humid atmospheric conditions there is a risk of condensation forming within Equipment which may cause deterioration of that Equipment or its malfunction. In every case the Contractor will assess the risk of condensation formation for all relevant points within the installation and shall take all necessary measures to protect Equipment against the formation of condensation.

These measures may include, but not be limited to, ventilation, either natural or forced; removal of temperature differences by means of anti-condensation heaters; or the use of equipment insulated sufficiently to allow self-heat to act as anti-condensation heating.

Wherever necessary where Equipment passes from an area at one temperature to an area at a different temperature, condensation traps with drains shall be provided.

4.10.3 **Damp**

Where Equipment is to be installed outdoors or indoors on surfaces which are, or which may become, damp it shall be constructed, finished, and installed to prevent deterioration. Wherever necessary to ensure the design life of Equipment is shall be spaced off damp surfaces sufficiently to allow circulation of air between the Equipment and the damp surface. When assessing the potential for dampness of internal surfaces the Contractor shall consider the porosity of materials used for the building fabric, especially single skin walls exposed to the weather.

4.10.4 **Water**

Where Equipment is installed indoors or outdoors it may be subjected to contact with water under a number of circumstances. These vary in degree and intensity and include:

- permanent or periodic immersion in water
- casual spraying with water during rainfall
- casual or periodic spraying with water from a hose or pressure sprayer
- casual covering, either wholly or partially, with snow or ice
- any other means by which equipment may be exposed to water

The Contractor shall assess the degree of risk and shall ensure that the Equipment chosen is designed and installed to operate in those conditions and prevent the ingress of water as necessary to prevent deterioration or malfunction.

4.10.5 **Ground Water:**

In some instances the exterior walls of premises may be below ground and the exterior surfaces of these walls may be subjected to ground water pressure either permanently or occasionally when weather or seasonal conditions prevail. In coastal areas this water may be tidal and may contain salt. Equipment mounted on, or passing through, such walls must be selected, installed or sealed such that they are not subject to deterioration by the exposure and such that they do not affect the ingress of water into the premises.

Where a waterproof render system has been applied to the internal or external surfaces of the premises, the Specialist contractor who applied the render shall be consulted regarding fixings and penetrations to ensure that any guarantees are maintained.

4.10.6 **Dust:**

The Contractor shall evaluate the risk of dust penetration into the Equipment for every location within an installation and shall select Equipment adequately protected to prevent deterioration or malfunction by dust ingress for the design life of the installation.

4.10.7 **Physical Contact:**

The Contractor shall assess the risk of injury or electrical shock due to contact with energised parts for each location within an installation, and shall select equipment or provide protection to prevent contact, appropriate to the risk involved. Special careful consideration shall be given to areas where the general public have access, especially children who it should be assumed will not appreciate the risks involved or read warning signs.

4.10.8 **Mechanical Damage:**

All Equipment shall be protected against mechanical damage, whether accidental, anticipated or by vandalism. Protection shall be appropriate to each situation and may consist of, but not be limited to, the following:

- enclosure in metallic or other ducts or conduits
- covers of steel or other suitable material
- total enclosure in a suitable housing
- enclosure by a suitable guard rail

- protective buffers

In certain instances individual isolated items of Equipment may require protection against mechanical damage, for example, lighting switches or socket outlets in exposed positions, and these shall be as outlined in the particular specification.

4.11 **Handling of Equipment**

All equipment shall be provided with suitable means for handling and placing into position. These shall include lifting points, eye bolts, sling positions or any other recognised method appropriate to the particular item of equipment.

The Contractor shall ensure that manufacturers indicate, by means of removable labels or similar marking, the slinging or lifting positions and the allowable weight that may be suspended at each lifting point to prevent incorrect handling on-site. For all items of Equipment requiring the use of a mechanical lifting device, for example, a crane or fork lift truck, to place them into position, the use of such a device shall be discussed with the Architect to ensure that the most appropriate lifting device is used. Where the use of such a device can be co-ordinated with other trades to minimise costs this shall be done.

4.12 **Methods of Fixing**

The Contractor shall allow for the design, supply and fixing of all necessary brackets, plugs and bolts on stanchions, walls, ceilings etc., where required to securely fasten, conduit, switch boxes, saddles distribution boards, and other accessories and items of equipment in position. Such brackets must be of a type, make and pattern approved by the Engineer, who shall also approve the methods of fixing.

The boring or notching of structural steelwork, reinforced concrete beams, wood joists etc., for cable runs and/or fixings shall be kept to a minimum and must receive prior written approval from the Engineer.

All holes for plugs shall be cut or drilled by the Contractor, who must include for such works in his tender.

The Contractor must ensure that all conduits, luminaires, inserts etc., to be cast in-situ are plugged and securely fixed to prevent movement or ingress of grout etc.

Conduit, luminaires and all other parts of the electrical installation shall not be fixed to any other adjacent services such as air ducts or sprinkler pipes, etc.

Equipment shall be installed using the following methods of fixing into each material, unless detailed otherwise in these specification documents, or as requested by the Engineer.

4.12.1 **Timber:**

Wood screws and nails shall only be used for small items; all pipework, ductwork trunking and cable tray supports shall not be secured in this manner, but shall use coach screws, coach bolts and bolts. All bolts shall be located at least 8 shank diameters apart. Pilot holes of the diameter and depth recommended by the manufacturer shall be drilled before fitting coach screws, and the complete thread of all coach screws shall be engaged into the timber.

Where the shank of a coach screw, coach bolt or bolt enters the timberwork, clearance shall be drilled for the appropriate length to prevent the timberwork splitting.

4.12.2 **Brickwork, Blockwork or Concrete:**

All fixings into brickwork blockwork or concrete shall be by woodscrew and plug, by grouted mild steel bolts or by an approved form of raw bolt. When drilling, care shall be taken to avoid crumbling of the material around the hole. Holes in the face of a concrete beam shall be sufficiently distant from the lower edge so as to avoid the reinforcing rods, and to prevent flaking of the beam.

4.12.3 **Steelwork:**

Fixings to steelwork shall wherever possible be made using clamping systems which do not involve drilling the metalwork, but which provide a secure mounting. Other fixings shall be by means of setscrews or bolts and nuts of appropriate size. Each bolt or setscrew shall be fitted with a plain washer and a shake proof washer under the nut. Where it is not possible to fit a nut, a tapped hole shall be provided, the plain and shake proof washers being fitted under the bolt head.

4.12.4 **Foundation Bolts:**

The Contractor shall provide and install all necessary foundation bolts, wall fixing bolts, rag bolts etc. for all apparatus and materials supplied under this contract.

Fixings to light gauge panels, of any material, which are inaccessible at the back shall be by means of shake proof self-tapping screws or by raw plug spring or gravity toggles.

Explosive powered fasteners shall only be used in steelwork thicker than 5mm and for shear load applications. The manufacturer's safety instructions shall be fully observed.

The size of the bolt or screw used must be the largest permitted by the diameter of the hole in the equipment to be fixed. All bolt or screw holes provided in equipment shall be used and each fixing must be secure. Countersunk heads shall be used where countersunk holes are provided.

The Contractor shall ensure that all fixings are chosen to suit the environment in which they are to operate and that deterioration due to chemical or electrolytic action does not occur. All screws and bolts shall be sheradised, with the exception of those used for sanitaryware, which shall be stainless steel.

No fixings shall be made to structural elements without the approval of the Engineer. The contractor shall provide the Engineer with a schedule, to be passed to the Structural Engineer, indicating all proposed fixings, which are subject to a point load in excess of 1kg. The schedule shall detail all items being fixed and the material being fixed into. The Engineer will comment within 10 days of receipt of this schedule, and no fixing of the items detailed shall commence until the methods have been approved.

Where the Contractor proposes to install equipment on chain or wire suspensions then care shall be taken to ensure that the wire and chain have adequate strength to support both the Equipment and any forces that may be imposed upon it during installation and normal usage. Chains shall be of welded closed link construction conforming to BS 6405 and shall generally have 40 links per metre unless the specific location requires the number of links to be different. Chain shall generally be galvanised unless an alternative plated finish is required to suit particular environmental conditions.

Wire shall be galvanised and shall comply with BS 183 and shall generally be of the multi-strand type.

Wire and chain shall be attached to Equipment by means of closed hook type suspensions or eye-bolts as appropriate which shall be manufactured from iron and steel. Soft alloy devices shall not be used. Suspensions shall be galvanised or paint finished according to the location. The chosen method will ensure the same carrying capacity as the wire or chain. Where it is necessary to form loops in wire for attachment to Equipment or the point of suspension this shall be achieved by means of suitable galvanised loop formers and clamps. Clamps may be of the bolted type or of the compression type and a double clamp shall be employed in every case for security.

4.13 Low Voltage Distribution Boards

4.13.1 General

All distribution boards shall be of the sizes and types specified and shall be fitted with air circuit breakers, moulded case circuit breakers, miniature circuit breakers, residual current devices or HRC fuses as detailed in the particular specification or drawings. Where distribution boards are specified to be complete with an isolator and/or restricted current circuit breaker, they shall be integral within the distribution board enclosure. Isolators shall be double pole for SP&N distribution boards and triple pole with neutral link for TP&N distribution boards.

4.13.2 Standards

- BS EN 60947:1992
- BS159 : 1992 Busbars
- BS5486 : 1990
- BS EN 60439: 1990
- BSEN 60898
- BSEN 60947
- BSEN 60947-2

4.13.3 Distribution Board Construction

The enclosures shall comprise a case and door(s) of sheet metal. The type of construction shall be damp and dust protected to classification IP31 minimum. Surface mounting shall be office pattern, fitted with cylinder key lock. Doors shall be provided with quick release hinges.

Sheet steel shall be Electro-zinc coated to a minimum thickness of 0.009mm and chromate washed. All door furniture (e.g. locks, handles, fasteners, etc.) shall be chromium plated. Paint finishes for all steel for use indoors shall have two coats of rust proof primer, then filled as necessary and flattened to a smooth finish, then two undercoats and the final finish being two coats of epoxy resin paint, the final coat drying to a hard semi-gloss surface. Colours of all internal surfaces for both indoor and outdoor use of sheet steel fabrications shall be white semi-gloss. External colours shall be to the approval of the Engineer.

All bright machined parts shall have a protective treatment applied by the manufacturer before despatch and this treatment is to be kept intact up to the time of handover unless it has to be removed for installation. If the surface is then exposed

after installation the Contractor shall apply a further protective coating in accordance with the manufacturer's requirements.

Unless otherwise defined within the particular specification all Distribution Boards shall be surface-mounting and adjustable for flush mounting, with the aid of a kit or other means.

The enclosure and door shall be made of electro-zinc coated sheet steel with an epoxy powder finish and high protection against corrosion (2000 hours salt spray).
The enclosure shall be fully factory-assembled into a single rigid structure and of sufficient size provided minimum gutter space on all sides.

Busbars shall be rigidly mounted in the same position on all poles relative to their banks of fuses or MCB's and fully shrouded to enable spare ways to be wired whilst the board is live. Busbars shall be copper to BS 159: 1992 and BS 5486 : 1990 and BS EN 60439:1990 (IEC 439).

All incoming terminals shall be fully shrouded and of the pressure clamp or socket type.

Renewable labels in the form of cards in a transparent envelope shall be provided within the enclosure for recording the following information for each circuit:

- Circuit Designation
- Cable Size
- Circuit Rating

The sequence of identification shall be indelibly marked on the label card. The make and type of fuse that discriminates and/or protects the miniature circuit breakers shall be indicated. If the installation of fuses comprises those other than the manufacturer stated, or would not discriminate or protect the miniature circuit breakers, then a label to this effect shall be installed in the distribution board.

Each distribution board shall be provided with an identification label, which shall be permanently screw fixed to the front.

All such external labels shall be white traffolyte with engraved black letters.

Neutral and earth terminals shall be provided, one for each outgoing phase way, in positions respective to their phase terminals. All neutral terminals shall be fully shrouded.

Where required, distribution boards specified with a clean earth, will be supplied with a fully insulated clean earth bar with one terminal for each outgoing phase way.

Distribution boards will be of the following types:

4.13.4 **MCCB Distribution Boards**

The boards shall be designed to accept current-limiting moulded case circuit breakers from 63A to 225A and shall be rated for the intended voltage (240/415V ac 50 Hz). The boards shall conform to BS 5486 Part 12:1989 and BS 5486 Part 1:1990 and have a 250A MCCB incoming device fitted as standard, unless defined elsewhere.

4.13.5 **MCB Distribution Boards**

The boards shall be designed to accept current limiting miniature circuit breakers from 1A to 63A and shall be rated for the intended voltage (240/415V ac 50Hz). The boards shall conform to BS EN 60439-1: 1994 (distribution boards) and BS 5486A13:1989 (consumer units).

4.13.6 **Interiors**

All interiors, with the exception of the circuit breaker and incoming devices, shall be completely factory-assembled.

Moulded case circuit breaker distribution boards shall have busbars of copper construction, rated to a minimum of 250A and shall be of the fully shrouded type.

Miniature circuit breaker distribution boards shall have busbars of copper construction, rated to a minimum of 100A, and shall be of shrouded type.

The busbar rating will be suitable for the fault level at its point of installation.

An integral disconnector shall be fitted to comply with the 17th Edition IEE Wiring Regulations, suitable for isolation, shall be incorporated in the connection to every outgoing way.

If required, the outgoing circuit breakers shall be fitted with add-on tripping or signalling devices. This shall be possible either on installation or retrospectively, with no special tools being required.

There shall be a choice of incomer between direct connection, switch disconnector and residual current device. It shall be possible to equip the boards with a moulded case incoming circuit breaker of up to 225A. An extension box shall be available for use with the MCCB.

The integrity of the incoming connection shall be enhanced with the aid of incoming cable cleat.

The range of distribution boards shall include a split-load board and one which can accept both distribution and control devices, enabling complete installations, including control devices, to be sourced from one supplier.

A range of add-on extension boxes shall be available, to enable control devices or up to 15SP outgoing ways to be associated with the standard TP&N distribution board.

The range of distribution boards shall be of a modular design, such that several boards may be conveniently group-mounted for large or awkward installations.

Additional Requirements for MCCB Distribution Boards.

4.13.7 **Pan Assembly**

All components and sub-assemblies shall be mounted on a strong chassis, consisting of 1.6mm-thick, zinc coated and passivated, folded sheet steel, with a Prisma Beige epoxy powder coated paint finish.

Busbars shall be made of hard-drawn, high conductivity copper. Busbars and associated connections are to be ASTA certified at 35kA for one second (minimum).

Fully rated neutral busbars shall be provided, each with a detachable link compliant with the 16th Edition of IEE Wiring Regulations.

Busbar supports shall be designed to withstand the maximum mechanical stresses under fault conditions detailed.

Ambient Operating Temperature:

MCCB distribution boards shall be suitable for operation at an ambient air temperature of 40°C, without any de-rating.

4.13.8 **Identification**

The following labelling shall apply to all distribution boards:

- Distinct labelling shall identify neutral and earth bar.
- Colour-coded phase labels shall identify supply and feed phases.
- Positive Contact Indication labels shall identify status of MCCB's and switch disconnectors.
- An electrical hazard label shall be visible upon removal of the front cover.
- Combined installation instructions and circuit record chart shall be provided with each board.

4.13.9 **Electrical Characteristics**

Rated insulation voltage: 500V AC
Maximum rated current of busbars: 630A
Rated minimum short-time withstand current of busbars:
3-phase - 35.5kA for 1 second; 75kA peak phase and neutral - 22kA for 1 second; 46kA peak.

4.13.10 **Incoming Devices**

The MCCB distribution boards shall be arranged to accept incoming supplies rated up to 630A via:

- Switch Disconnector
- Moulded case circuit breaker of appropriate rating

4.13.11 **Outgoing Devices**

The boards shall be arranged to accept outgoing moulded case circuit breakers of the following maximum ratings:

- Power distribution board: 100A, 1- and 3-pole
- Panel board: 100A, 1-pole and 225A, 3-pole

All breakers, both incoming and outgoing, shall be manufactured to BS EN 60947:1992 and be in accordance with general moulded case circuit breaker specification, dealt with elsewhere in this specification.

4.13.12 **Instrumentation**

All boards with an incoming breaker of 400A and above, will be supplied with a factory fitted ammeter (L1, L2, L3) and voltmeter (L1, L2, L3, L1N, L2N. L3N).

4.14 Protective Devices

4.14.1 General

The Contractor shall ensure that where protective devices are specified within the particular specification and elsewhere within this specification they meet the following standards and configuration requirements.

4.14.2 Moulded Case Circuit Breakers (MCCB)

4.14.2.1 General

All MCCB's shall comply with BS EN 60947: 1992 (IEC 947) and be of the current-limiting design.

All MCCB's shall be designed for horizontal or upright mounting, without any adverse effect on electrical performance, and be suitable for reverse feeding.

4.14.2.2 Construction

The operating mechanisms shall be of the quick-make/quick-break type, with the speed of operating independent of the operator and mechanically trip-free from the operating handle, to prevent the contacts being held closed against a short circuit or overload condition. The operating mechanism shall be constructed to operate on all poles simultaneously in a multi-pole breaker, during opening, closing and tripping operations.

The circuit breakers shall be operated by a rotary handle or motor mechanism, which will clearly indicate the three fundamental positions:

- ON
- OFF
- TRIPPED

The breaking and extinction of the arc created during switching shall be achieved by means of non-welding contacts and arc chutes surrounding these contacts, with polyamide inserts to reduce arc quenching gas under short circuit conditions.

The circuit breaker shall be complete with Positive Contact Indication, which shall be maintained should the breaker be enclosed or fitted with any operating accessory, eg. rotary handle or motor mechanism.

All circuit breakers shall be manufactured with double insulation of the front face, insulating the auxiliary compartments from the main power poles, thus allowing the installation of auxiliaries without full isolation of the unit.

All accessories and electrical auxiliaries such as shunt trips, undervoltage releases, auxiliary contacts, motor mechanisms, shall be manufactured in such a way as to allow easy installation, either at manufacturer's works or on site.

The current limiting MCCB's with very high breaking capacities shall be made of two parts:

1. A standard circuit breaker to break small and medium fault currents.

2. A current limiting block to break and limit large short circuit currents. This shall be of the electro mechanical type (fuse free) and factory-fitted to the standard breaker.

All MCCB's will be suitably rated for the fault level at their point of installation.

4.14.2.3 **Operation**

For MCCB's up to and including 630amps, each pole of the MCCB shall be provided with a bi-metallic thermal element for inverse time delay protection and a magnetic element for short circuit protection. The thermal release shall be of the adjustable type and may be equipped with a sealing facility, should this be required.

Adjustments are to be made simultaneously on all poles, with a common adjustment facility.

MCCB's of 250amps up to 630 amps with thermal/magnetic trip units shall have fully interchangeable trip units.

MCCB's above 400 amps, the trip unit may be of a solid state type, energised by internally-mounted current transformers. It shall not require an external power supply to operate the tripping mechanism.

The current limiting MCCB's with very high breaking capacities must be capable of offering cascading and discrimination simultaneously.

The manufacturer shall provide a full set of current discrimination tables showing overload and short circuit discrimination, together with a full set of transparency characteristic curves, to enable discrimination systems to be checked.
Miniature Circuit Breakers

All miniature circuit breakers shall be rated to withstand the fault currents of the circuits they protect without causing any interference in any other protective device associated with the distribution system. At the same time, the design of the circuit breaker shall be such that it will protect the circuit for which it is intended and not cause or allow other protective devices to operate when fault conditions apply.

Miniature circuit breakers shall be in accordance with BS 3871 Part 1: 1990 and BS EN 60898:1991 (IEC 898) and generally as detailed below:
General

MCB's shall be fully tested to a minimum of 10KA: to BS 3871 : Part 1 and BS EN 60898 at 415V AC. All ratings of single, two, three, and four pole MCB devices shall meet this requirement.

All MCB's shall directly indicate the true position of the contacts from the handle and shall comply with the 16th Edition Wiring Regulations with regards to isolation and switching.

MCB's shall be suitable for mounting in any DIN standard enclosure. Base mounting shall also be possible.

MCB's shall be capable of accepting a full range of accessories.
Construction

The operating mechanism shall be mechanically trip-free from the operating handle, to prevent the contacts from being held closed against short circuit or overload conditions. The mechanism shall automatically reset.

The individual operating mechanism of each pole of a multiple MCB shall be directly linked within the MCB casing and not the operating handle.

The operating handle shall be of the toggle type, with facility for mounting a padlocking device.

Each pole shall be provided with a bi-metallic thermal element for overload protection and a magnetic element for short circuit protection.

Terminals shall be of the cage or tunnel type, in order to minimise the risk of human contact, and shall be capable of being tightened with both conventional and cross point screwdrivers. All screws shall be of the captive type.

MCB's shall be capable of accepting a full range of accessories, including earth leakage protection and remote tripping/indication modules. It shall be possible to fit these accessories either during initial installation of retrospectively and shall not require the use of any tools.

MCB's shall be capable of accepting a full range of shrouding accessories, including terminal shields and inter-phase barriers.

4.15 Low Voltage Cables

4.15.1 General

Unless otherwise defined within the particular specification cables, shall be provided with any required terminations by the Contractor.

4.15.2 Standards

Cables and associated materials shall be supplied in accordance with all British and International Standards including, but not limited to the following:

- BS 6004 - PVC Insulated Cables (non armoured)
- BS 7211 : 1989 - LSF Thermosetting Insulated Cables (non armoured)
- BS 6724 - LSF Thermosetting Insulated Cables (armoured)
- BS 5467 : 1990 - XLPE Insulated Cables (armoured)
- BS 6480 : Part 1 - Paper Insulated Cables
- BS 6622 : 1991 - Medium Voltage XLPE Insulated Cables
- BS 6207 : 1991 - MICS Cables
- BS 1442 : 1986 - Specification for galvanised mild steel wire for armouring and compression joints in electric cable and wire connectors
- BS 6346 : 1989 - Specification for PVC insulated cables for electrical supply
- BS 6360 : 1991 - Specification for conductors in insulated cables and cords
- BS 6746 : 1990 - Specification for PVC insulation and sheath of electric cables
- BS 6746C:1993 - Colour chart for insulation and sheath of electric cables

- BS 4579 : 1988 - Specification for performance of mechanical and compression points in electric cable and wire connectors
- BS 6121: 1990 - Mechanical Cable Glands

No cable smaller than 1.5 sq mm (stranded 7/0.53) shall be used.

Single core PVC insulated cables greater than 35 sq mm shall be 600/1000 volt grade manufactured in accordance with BS 6346:1989 and by an approved manufacturer. Conductors shall be stranded and of high conductivity annealed copper.

The insulation shall be self-coloured to indicate the phase of the circuit, the polarity of d.c. circuits and to differentiate between separate electrical services. Unless otherwise stated the colour coding shall comply with the requirements of Cable 51A of BS 7671:1992.

Cables shall be sized taking account of the applicable ambient temperature and grouping de-rating factors.

4.15.2.1 **Installation:**

Cables for any circuit shall not be installed into conduit or trunking systems until:

- The erection of the conduit and/or trunking system for that circuit is complete in every respect.

- Earth continuity tests have been satisfactorily carried out.

- All finishes except painting have been applied to the structure relevant to the particular run.

- Any surplus finishes have been trimmed to the internal size of the boxes.

- Any extension rings necessary to bring the rim of the box level with the finish have been installed.

- Trunking and conduit systems are clean and dry. A swab shall be drawn through all conduit runs and trunking with fixed lid. Trunking shall be swept and wiped clean.

Cables shall be drawn from cable drums mounted on spindles to ensure they are installed without axial twisting. All the cables to be installed in one conduit run shall be installed at the same time. During installation the cables shall be combined to facilitate installation and withdrawal.

A suitable length of cable shall be left at all connection points and be coiled up and "put away" in their enclosure or box awaiting connection. Boxes which are not to be equipped with an accessory prior to painting, shall be fitted with their covers. No joints shall be allowed in cables except in boxes for accessories.

4.15.3 **Single Core LSF Insulated Cables**

4.15.3.1 **Materials:**

Single core LSF insulated cables shall be 450/750 volt grade manufactured in accordance with BS 7211:1989 and by an approved Manufacturer. Conductors shall be stranded and of high conductivity annealed copper. No cable smaller than 1.5 sq mm (stranded 7/0.53) shall be used.

The insulation shall be self-coloured to indicate the phase of the circuit, the polarity of d.c. circuits and to differentiate between separate electrical services. Unless otherwise stated the colour coding shall comply with the requirements of Cable 51A of BS 7671:1992. Cables shall be sized taking account of the applicable ambient temperature and grouping de-rating factors.

4.15.3.2 **Installation:**

Cables for any circuit shall not be installed into conduit or trunking systems until:

- The erection of the conduit and/or trunking system for that circuit is complete in every respect.
- Earth continuity tests have been satisfactorily carried out.
- All finishes except painting have been applied to the structure relevant to the particular run.
- Any surplus finishes have been trimmed to the internal size of the boxes.
- Any extension rings necessary to bring the rim of the box level with the finish have been installed.
- Trunking and conduit systems are clean and dry. A swab shall be drawn through all conduit runs and trunking with fixed lid. Trunking shall be swept and wiped clean.

Cables shall be drawn from cable drums mounted on spindles to ensure they are installed without axial twisting. All the cables to be installed in one conduit run shall be installed at the same time. During installation the cables shall be combined to facilitate installation and withdrawal.

A suitable length of cable shall be left at all connection points and be coiled up and "put away" in their enclosure or box awaiting connection. Boxes which are not to be equipped with an accessory prior to painting, shall be fitted with their covers. No joints shall be allowed in cables except in boxes for accessories.

4.15.4 **XLPE, Insulated, PVC Sheathed, Armoured Power Cables and LSF Applications**

4.15.4.1 **Materials**

XLPE, Insulated, PVC Sheathed Armoured multicore power cables shall be 600/1000 volt grade manufactured in accordance with BS 5467:1989 and by an approved manufacturer. It shall consist of high conductivity annealed copper stranded conductors,

XLPE insulated, extruded bedding, and a single layer of galvanised steel wire armour.

The cables shall incorporate a PVC oversheath coloured black.

In instances where low smoke zero Halogen armoured cables are detailed, the following shall apply:

XLPE Insulated, LSF Sheathed Armoured multicore power cables shall be 600/1000 volt grade manufactured in accordance with BS 6724:1990 and by an approved manufacturer. It shall consist of high conductivity annealed copper stranded conductors, XLPE insulated, LSF fillers and binders, LSF extruded bedding, and single layer of galvanised steel wire armour. The cables shall incorporate an LSF oversheath coloured black. .

4.15.4.2 **Cable Identification**

Each end of cable shall be provided with an identification label. Labels shall be permanently attached to the cables in an approved manner, loose tags will not be accepted. The materials of the labels and fastenings shall be such as to avoid corrosion due to incompatibility of materials and to ensure permanent legibility. All identification shall be in accordance with BS 3858: 1992 and BS 5559: 1991.
Installation

Cables shall be installed in accordance with the requirements of BS 5467 and BS 6724, and the manufacturer.

Cables shall be delivered to site, and stored, on a cable drum with the manufacturers label attached.

Cables shall be fixed to cable trays, the building fabric/structure, laid in trenches and installed in ducts as detailed on the drawings.

A clearance of 300mm is to be maintained between cables and other equipment or pipework, including lagging etc. Where this condition is difficult to comply with a ruling is to be obtained from the engineer prior to the installation being commenced. If this is not done the engineer may require the cable to be diverted or fixings adjusted at no additional cost.

Cables shall be supported using claw cleats with LSF properties where such cables are used, at centres not exceeding the manufacturer's recommendations.

Additional cable cleats are to be provided on cable routes, which are subject to numerous changes in level and direction or where structural beams or other building features or pipework, ducts etc., exist, so that cables clearly and neatly negotiate all such obstacles.

Fixings used in damp, potentially damp or exterior locations are to be hot dipped galvanised after manufacture.

The minimum internal bending radius of the cables shall not be less than those detailed by the manufacturer.

Care is to be taken to ensure that the cables are not twisted or kinked.

The current ratings of cables have been based upon:

a) Single layer of cables on perforated trays touching.

b) Buried at 450mm below ground level not bunched.

Cables shall be installed only using these methods, i.e. stacking of cables will not be permitted.

To facilitate the installation of cables the drums shall be supported by either Jack stands or a drum cradle to allow the cable to rotate freely whilst the cable is drawn through ducts laid in trenches or on cable trays.

Wire cable stockings are to be used with pulling ropes when pulling cables through ducts.

The Contractors attention is drawn to the need to observe the warnings provided in BS 6724 and BS 5467 which relate to the cables being installed during periods of low temperature which states "to avoid damage during handling, the cable shall only be installed when both the cable and the ambient temperatures are above 0°C and have been so for the previous twenty four hours, or where special precautions have been taken to maintain the cable for the temperature".

Once all cables have been drawn into ducts, all holes shall be sealed by a waterproof sealing compound to prevent the ingress of water, vermin etc.

Where cables are run in trenches they shall be installed at a constant depth of 450mm. below finished ground level. The Contractor shall be responsible for ensuring their cables are back-filled with outer 100mm cover of stone free graded earth.

The Contractor shall install a continuous warning marker tape 250mm. below finished ground level along the full length of the cable route.

No joints will be permitted along the cable run.

Where cables pass through walls, floor, ceiling etc. the holes shall be made good with incombustible material to prevent the spread of fire. Where the walls, floor etc. form a fire barrier the cables shall be enclosed in a steel sleeve and space around the cable in the sleeve shall be plugged with insulating material.

4.15.5 **Termination**

The method of stripping the sheath, filler and insulation shall be as recommended by the cable manufacturer and shall be such that no damage is caused to the insulation or conductor. Each cable gland shall be fitted in accordance with the manufactures recommendations and shall be of the correct type and size for the specific application and location. All joint faces shall have suitable gaskets. Glands for single core power cables, if metal sheathed, shall be fixed on non-ferrous metal plates, so arranged as to prevent the flow of eddy currents in the cable boxes.

Cable glands for PVC insulated cables shall as a minimum be of the two stage compression type which grip both the cable sheath and the armouring independently and incorporate an external earthing lug. A black PVC (or LSF where such cables are used) shroud shall be installed. Three stage weatherproof glands will be used on all external terminations.

Cable tails shall be terminated onto equipment by means of solder less compression type cable lugs applied to the conductor by means of a hydraulic crimping tool. Cables entering cable end boxes, switchboards and other electrical equipment shall be installed straight for a distance of not less than 300mm from the cable gland.

4.16 Cable Management Systems

4.16.1 General

Cables shall be delivered on drums and properly protected against mechanical damage. Each drum when delivered, shall be accompanied by a certificate giving Manufacturer's name, works order number and results of tests made at works. Where lengths are cut from cables, the open ends shall be sealed.

Where cables of differing voltages are installed in close proximity, cable identification shall be provided. Cables will be installed on cable trays, cable ladders, in trunking, fixed to structures with unistrut and clamps/cleats direct buried or in ducts as shown on the drawings. Any other type of installation of fixing shall require authorization by the Engineer.

4.16.2 Cables on Trays and Ladders:

Cables shall be installed on trays or ladders such that each cable runs parallel to its neighbour and be neatly laid in rows such that as cables leave the tray or ladder they do not cross over other cables.

Cables leaving trays should either pass through the bottom of the tray through neatly cut holes with suitable grommets or lead flashing or over the return flange, the cable should be supported away from the flange. Depending on the size of the slot the tray should be either strengthened or have further support. Cables shall not leave the tray and trail over the return flange.

Cables leaving ladder shall pass through the rungs of the ladder. Whereby recently they have to leave over the edge of the ladder they shall either be supported away from the edge or the edge be provided with suitable covering to protect the cable from damage. Only two layers of cables are allowed on trays unless approved by the Engineer. Cables on ladders may have more than two layers but the top of the uppermost cable must be below the edge of the ladder flange.

Cables where not specified to be cleated shall be tied to the tray or ladder by plastic cable ties minimum size of 5mm and at such intervals to prevent "bowing" of the cables. Power cables should be segregated as far as possible and tied down individually.

4.16.3 Bending Radii of Cables:

Bends in cables shall be as large as possible and in accordance with the cable Manufacturer recommendations.

4.16.4 Cleats and Saddles:

Cable cleats shall be manufactured in pressure die cast silicon aluminium grade LM6-M to BS 1490: 1988. Cable cleats shall be manufactured in two identical halves and secured to the support system by two studs or bolts suitable for fixing to the support system. These shall be provided in all vertical and horizontal runs of cables.

Cleats for single core metal sheathed cable carrying alternating current shall be so as to avoid the setting up of a magnetic circuit through any steel or iron work. Single core cables carrying alternating current or three cables arranged in trefoil formation with the cables touching and where departures from the trefoil formation cannot be avoided,

approved arrangements shall be employed to minimise sheath currents or other undesirable effects.

The cleating arrangements for single core cables shall be of the sufficient strength to withstand the forces set up during short circuit conditions. Where installed on trays, cables not provided with cleats shall be secured by heavy gauge copper or plastic coated clips or saddles at intervals of not more than 600mm, not more than 6 cables shall be embraced by one clip, and not more than two layers of cables shall be installed on one tray.

Where installed on walls or flat surfaces, cables shall be secured by cable cleats at intervals of not more than 600mm. Every cable shall be securely supported throughout its length and at a point not more than 100mm from its termination, and on vertical routes passing through a floor, immediately above the floor. Any alternative method of fixing shall be approved by the Engineer.

4.16.5 **Cables Installed in Service Ducts and Cable Tunnels:**

Where installed in service ducts cables shall be installed at least 25mm clear of walls and ceilings on cable cleats. Cable cleats shall be fixed to the galvanised rolled steel cable support system at spacings to provide satisfactory cable support.

Where cables emerge from a service duct and rise up a wall, a length of suitable sized galvanised steel pipe, bushed at each end shall be threaded over the cable to 450mm above floor level so positioned as to protect the cable from mechanical damage.

4.16.6 **Fire Barriers:**

Where cables are routed through floors and main fire compartment walls, a system of proprietary fire barriers shall be installed by the Contractor. The fire barriers shall consist of a metal frame, complete with edge flange. After installation of the cabling, fire resisting neoprene type inserts and filler blocks shall be inserted around the cabling and the necessary stay plates, compression plates and end packing units installed. The Manufacturers recommended lubricant shall be used when packing the neoprene inserts and filler blocks into the fire barriers. In certain circumstances, the Fire Officer may specify an alternative infill for the fire barrier.

4.17 **Metallic Conduit and Fittings**

4.17.1 **Conduit Tubing**

Unless otherwise specified, all non-armoured cables shall be installed in heavy gauge, welded steel conduit using screwed joints. In general areas all conduit shall be finished with black enamel (Class 2). In plant areas, humid atmospheres and all external installations, conduit and fittings shall be installed with a galvanised (Class 4) finish.

Whichever finish is adopted, either black enamel or galvanised, it shall be maintained throughout the conduit system including all fittings and accessories. A mixture of finishes will not be accepted.

4.17.2 **Fittings**

Conduits and conduit fittings/accessories shall comply with BS 31 (with amendments) and be of heavy gauge, seam welded, steel tube screwed, having a hot dip galvanised finish to BS 4568 : Class 4 and BS 31 : Class 4.

The sizes of conduits used and the number of cables installed shall be strictly in accordance with the requirements of BS 7671, the smallest size being 20mm.
Conduit installed for the telephone system shall be installed complete with draw-in wires.

No bends, elbows or tees, solid or inspection type shall be used in the installation of metallic conduit unless authorised in writing by the Engineer. All bends shall be formed on site using suitable bending tools.

All junction boxes and draw-in boxes shall be of malleable cast iron circular type provided with a cast iron or pressed steel lid secured by brass screws. They shall be manufactured to BS 4568 Part 2.

Switches, socket outlets and spur units shall be mounted in galvanised pressed steel boxes suitable for conduit wiring systems.

4.17.3 **Installation and Fixing of Metallic Conduit**

Conduit installations shall be mechanically and electrically continuous throughout. Unless otherwise indicated all runs shall be either vertical or horizontal.

Conduits shall be installed as neatly and unobtrusively as possible.

Attention shall be paid to the installation of surface conduits. All corners and angles shall be neatly negotiated with vertical and horizontal runs kept straight and parallel to general building lines. No diagonal runs shall be permitted and all branches shall be taken off at right angles.

When concealed within concrete or floor screeds conduits shall be routed in a straight line where possible from point to point.

Conduit runs shall be left clear of gas or water pipes by minimum distance of 150mm.

Conduits crossing building expansion joints shall be fitted with expansion couplers at the position of the expansion joint. An earth wire shall be installed between the nearest conduit box at either side of the coupler. The back of the conduit box shall be drilled and tapped to a size not less than M4 and the earth connection made by means of an approved combination of terminal washer and brass screws.

A running coupler socket within 300mm above or below the floor on all vertical drops or pieces respectively shall be provided where conduit is cast into or passes through structural floors. Running couplers will be kept to an absolute minimum in all other instances.

Where conduits are installed in floors and the programme indicates that the screed is not to be applied within three days of the installation, then the conduits shall be protected by means of a hunching of a cement and sand mixture.

The conduit system shall be checked for and rigidity mechanical damage, before the floor screed is laid. Any damaged conduit shall be replaced.

Standard round boxes shall be used for all intersection and outlet points, except where the conduit terminates in accessories such as lighting switches, socket outlets, etc.

At intersection points on multiple conduit runs, steel adaptable boxes with light steel covers (overlapping for concealed conduit work) shall be used which shall have minimum depth of one and a half times the largest conduit entry. Cables from more than one distribution board shall not enter any single adaptable box.
No boxes shall be provided in any position where access cannot be readily obtained. No draw-in boxes other than point boxes shall be installed in the plaster wall or ceiling surface, where the conduit work is flush, except within cupboards and switch-rooms, or where specific permission is given by the Engineer. If permission is given, each box shall be made permanently accessible and so arranged to be neatly finished, flush with the finished surface of the walls, ceilings or floors.

Joints in conduit runs shall be by means of screwed fittings, the threads being cut by suitable dies and screwed up tight. After each thread is cut it shall be cleaned with a wire brush and wiped with a clean cloth to remove all traces of cutting fluid or grease. The bore of the tubing shall be reamed out to remove all sharp edges and filed square.

Conduit shall be terminated in threaded spouts for conduit boxes or in clearance holes for adaptable boxes, switch boxes, enclosures of equipment and trunking. Where conduits terminate in clearance holes they shall be provided with a coupling, brass male bush and earth continuity washer.

All vice marks shall be removed from all conduits and fittings. Where the finish is damaged black enamel paint shall be applied to indoor conduit or an approved zinc rich paint to galvanised finished conduit.

No thread shall be exposed except at running couplers where they shall be painted with the appropriate primer and/or paint.

Running couplers shall be backed by a securely locked heavy gauge lock nut.

All couplers shall be securely tightened and care shall be taken to ensure that conduit ends do not butt.

Where called for within the particular specification conduit shall be concealed in floor screeds or wall finishes except where fixed to exposed steelwork. Wall chases shall accommodate the full depth of the conduit.

Conduit runs shall be so arranged that all wiring may be carried out and later removed from draw in box positions.

Draw-in boxes shall be provided at points no further apart than 9 metres and no run shall have more than two right angle bends between draw-in boxes.

The conduit shall be fixed by means of cast iron distance or spacer bar saddles with bars not less than 6.4mm thick except where fixed to wood in which case ordinary saddles may be used.

Where conduit is, or may be, in contact with any structural steelwork, an efficient and permanent metallic connection shall be made between them.

Fixing to beams, girders or structural metalwork shall be completed by means of approved fasteners, which do not require drilling.
Saddles shall be spaced at maximum intervals of 1400mm and at a distance of 225mm either side of a box using No. 8 wood screws not less than 25mm long with Rawl plugs of similar. In joint mortar the screws shall be 40mm long. Fixings shall be applied only to

concrete, brickwork, timber and breeze or tile partitions. All fixing works shall be drilled with masonry drills. Shot fired fixings will not be accepted.

Conduits fixed in screeds or chases, which are to be rendered and plastered shall be fixed by steel crampets.

Boxes used as point boxes and all switch and socket outlet boxes shall be fixed by means of No. 8 wood screws, 25mm long using Rawl plugs or similar except as given below.

Countersunk screws shall be used for fixing only where special countersunk holes have been drilled or provided. Round headed screws used for all fixings shall be black japanned finish. Screw heads shall have burrs and sharp edges removed before wiring commences and all screws are to be driven into their correct depth. Box lids shall be fitted by means of brass round headed M4 screws. All such boxes shall be securely fixed by means of at least two screws such that the screw threads do not project into the box and damage cables.

Falls for drainage purposes shall not be provided in conduit runs nor shall pockets be formed within any conduit system in which moisture may collect. Drainage holes however shall be provided at suitable positions agreed by the Engineer.

Where conduit passes through any wall, floor or ceiling from a high temperature area to a low temperature area, a conduit box shall be inserted close to the wall, floor or ceiling on the high temperature side shall be filled with cold compound. A neoprene gasket shall be inserted between the lid and the base where these are galvanised.

The conduit system shall be tested for satisfactory electrical continuity where applicable, before plastering or screeding and before cables are drawn in. The tests shall be witnessed by the Engineer.

Where a conduit installation is subsequently covered by a wet applied finish, it shall be plugged with a removable material to exclude any plaster, concrete or other wet material.

Each conduit system shall be completed, dried out, cleaned and tested to the satisfaction of the Engineer before any cables are drawn-in. In concealed installations cables shall not be drawn-in until all plaster, screeds or other finishes have been completed.

Where required by the Engineer, the Contractor shall demonstrate rewire ability of conduits by drawing a number of cables from conduits selected by the Engineer and replacing by a new cable.

4.18 **Flexible Conduit and Connection**

Where the connection of solid conduit direct to equipment is not possible or desirable, as in the case of plant requiring adjustment or where vibration occurs, the conduit shall terminate at a position adjacent to the equipment and the wiring continued in a manner given below:

1. Where the supply voltage is at or below 240V the wiring may be continued in suitable flexible cable of appropriate rating. The connection shall be made in a fixed socket and each end of the flexible cable shall be secured by means of gland or clamp.

2. Where the supply voltage is in excess of 240V flexible conduit shall be used. Such conduit shall be constructed from a double layer of continuous strip wound helically, overlapping and rolled to form a deep close pitch thread. The exterior shall be sheathed with an extrusion of a low smoke and toxic fume emitting compound. A separate protective conductor shall be run inside the flexible conduit and connected to suitable terminations at each end of the flexible conduit.

The cable shall be a minimum of 2.5mm in csa (stranded conductor) unless defined otherwise by the particular specification.

A minimum length of 300mm and of sufficient length to allow the full range of withdrawal, adjustment or movement necessary.

4.19 **Cable Trunking Systems**

Steel surface cable trunking shall comply with BS 4678 : 1988. Trunking and associated covers shall have return edges. Captive cover fixings shall be provided to both securely fix the cover and give adequate earth continuity between the trunking body and the cover. Cover fixings shall be of the lever type operated by means of a screwdriver.

Trunking up to and including 150mm x 50mm is to be made of not less than 1.2mm sheet steel and sizes above are to be of not less than 1.6mm sheet steel.

All screws used to join trunking lengths together and to trunking accessories and equipment shall be pan head machine screws finished to be compatible with the protection class of the trunking. The ends of the screws shall not project into the cable space. Self-tapping screws shall not be used.

All trunking accessories shall be factory made and be of the same finish and metal gauge as the trunking with which they are to be used. All bends shall use accessories having internal gusseted corners to ensure that cable bending criteria is adhered to. Site made bends, sets, lids and flanges shall not be used. The finish of the trunking shall, in addition to the finish detailed in BS 4678: 1988, be stove enamelled inside the trunking and cover or be galvanised as specified.

4.19.1 **Trunking systems as the circuit protective conductor:**

Steel surface trunking systems may form the whole or part of a circuit protective conductor. The final trunking system shall be checked to ensure that it can satisfactorily carry the current it will conduct under earth fault conditions and that it shall so remain for the life of the installation. The cover of the trunking shall not be deemed to form part of the circuit protective conductor and shall be excluded for the purpose of calculation earth loop impedances, thermal ratings, etc.

4.19.2 **Cable in steel surface trunking:**

The Contractor shall ensure that the size of the trunking system is such that the number type, size and current rating of the cables are accommodated in accordance with manufacturer's instructions and without damage to the cables and in accordance with the requirements of BS 7671.

The Contractor shall be responsible for determine the size and route of all trunking systems and shall obtain the Engineer's approval with respect to routes and sizes before

installation commences. Trunking sizes shown on the Engineer's drawings shall be taken as notional.

Such trunking shall be capable of containing 50% additional cables of the average size of the conductors to be installed in the trunking.

Where ever practical, unless otherwise stated the Contractor shall look to use multi-compartment trunking. The method of fixing/support will be agreed with the Engineer prior to installation.

Where trunking is used to carry more than one service, it shall be sub-divided into separate compartments for power, telephone and auxiliary services.

4.19.3 **Installation:**

Trunking shall be installed in a neat and workmanlike manner. Indication routes only are shown on the drawings and the working drawings shall reflect the final installation (and shall be co-ordinated with other services) and be approved by the Engineer. Site cutting of lengths of trunking shall be true and square. (All cut edges shall be prepared and treated with a zinc rich paint). Drilling of the trunking for couplers and earth links shall be made using a jig and all burrs from the cutting and drilling processes shall be removed and the cut edges protected to be compatible with the protection class of the trunking.

Electrical continuity across all joints tunnel in the trunking system shall be ensured by the use of the propriety copper earthing links. Where trunking with a stove enamel finish is specified the enamel shall be carefully removed under the area of the screws securing the link.

Trunking covers shall be cut square and where necessary cut for the installation of trunking cover fixing accessories. All burrs shall be removed and the cut edges protected to be compatible with the protection class of the trunking. Covers shall be installed with the trunking installation and shall butt closely together. Each cover piece shall be fixed in at least two places along its length. The distance between cover fixings on each cover shall not be more than 1000mm. Trunking covers shall be completely removable throughout its entire length, and shall be supplied in lengths no greater.
Every length of trunking and every trunking accessory shall be independently fixed to the structure of the building by pan head or round head screws finished to be compatible with the protection class of the trunking. Connections between trunking and equipment shall be made via a standard flanged connector, such as screwed conduit coupler and male hexagon brass bush or such other arrangement agreed with the Engineer. All arrangements shall present a smooth path for the passage of cables.

Adjoining sections of trunking shall bolt tightly and shall be joined by means of an internal fish plate connection, attached by means of steel bolts, passing through clearance holes.

Where connection is made between trunking and distribution board the cable entry shall be sized to accept cables from both used and spare ways. Holes in trunking shall be neatly drilled with a drill or hole saw and all edges smoothed with a file and painted with zinc rich paint.

Cable retaining straps or springs shall be installed at 450mm centres throughout the length of the trunking. In all vertical runs and in horizontal runs of trunking where the

vertical dimension of the trunking is 100mm or more pin racks shall be installed at 1200mm centres or less to provide support for the cables.
Where trunking passes through floors and walls a fixed length of cover which projects 75mm on either side of the floor or wall shall be provided. Where the floor or wall forms a fire barrier the trunking shall be packed with glass wood for the length of the fixed cover. Trunking systems shall be installed with at least 150mm clearance from other fixed metalwork including pipes and ducts associated with other building services.

Where trunking passes through fire barriers, walls or floors, delineating a fire compartment of the building the trunking shall be provided with internal fire barriers in accordance with the requirements of BS 7671 and as directed by the Architect.

Where trunking passes from a normally heated to an unheated area, a barrier shall be provided within the trunking to prevent air convection currents and consequent condensation within the trunking.

Any brackets or supports required for trunking systems shall, unless stated otherwise, be regarded as part of the trunking system together with their fixings. Brackets and supports shall be finished to give the same degree of protection as the trunking system supported.

No trunking system shall comprise components finished to more than one class. Where the finishes of trunking systems have been damaged they shall be made good to give the same degree of protection as when new. The making good shall be carried out within twenty four hours of the trunking being installed. The contractor shall allow for the installation of the fire barriers as appropriate.

Trunking shall be positioned so that adequate clearance is provided for access to the wiring.

4.20 **Cable Tray Systems**

Perforated metal cable tray shall be formed from plain sheet steel complying with BS 1449: Part 18, classification HR4/GP and hot dipped galvanised to BS 729 : 1994, unless other types of finish are specified within the particular specification.

Where defined within the particular specification the cable tray shall be manufactured to one of the following returned flange configuration.

1. Standard return flange 25mm deep
2. Medium duty flange 50mm deep
3. Heavy duty flange 80mm deep

The perforated cable tray shall be formed from plain sheet steel to comply with BS 1449: Part 1 : 1985 and each cable tray shall be manufactured from the following minimum gauge steel:

Width	Gauge
102mm	1.0
152mm	1.0
229mm	1.0
305mm	1.6
457mm	1.6
610mm	1.6

762mm 1.6

Cable tray shall only be cut along a line of plain metal, i.e., not through the perforations. All cut edges of galvanised cable tray shall be prepared and treated with a zinc rich paint. Site fabrication of accessories shall be kept to a minimum and manufacturer's standard items shall be used. Where special sections are required, the material, thickness and finish shall be as specified for standard items.

Where welding has been employed in the fabrication of cable tray and/or accessories, the area around the joint shall be mechanically prepared and thereafter treated with zinc chromate primer or zinc rich paint according to the original finish of the metal. Holes cut in cable tray for the passage of cables shall be provided with grommets complying with BS 1767: 1951. Alternatively, they shall be bushed or lined.

A minimum clear space of 20mm shall be left behind all cable tray for securing cable strap. Supports for cable trays shall be disposed at regular intervals not exceeding 1200mm and at 225mm from bends and intersections. The maximum deflection of cable tray will not exceed 5mm through its entire length.

Fixings shall be fabricated from mild steel flat bar complying with BS 7613:1994 and BS 7668:1994. When used with galvanised cable tray, fixings shall be hot dip galvanised, unless only bending and drilling is required in the manufacture, when galvanised mild steel flat bar may be used. Hot dip galvanising shall comply with BS 729: 1994.

Coach screws shall comply with BS 1494: Part 1 1964 and wood screws with BS 1210: 1974. Where used with galvanised fixings, screws shall be steel, zinc plated electro-galvanised to comply with BS 1706: 1991 class B coatings.

Cable tray may be used as a protective conductor in accordance with the requirements of BS 7671.

Where cables enter or leave cable trays, the Contractor shall ensure that no sharp edges are carrying the weight of cables and that no cables subject to vibration are in a position where they could be abraded by the cable tray.

4.20.1 **Bends**

Bends shall be of the same material, thickness and finish as the cable tray and shall have an inner radius to suit the bending radius of the cable and a straight length of 100mm at each end. No perforations shall be made in the circular portion of 100mm and 150mm bends. On 225mm and 300mm bends perforations shall be made only along a line set at 45 degrees. On 450mm and 600mm bends perforations shall be made only along lines set at 30 degrees and 60 degrees.

4.20.2 **Tees**

Tees shall be of the same material, thickness and finish as the cable tray. The distance measured between a point of intersection and the end of the fitting shall be 100mm.

4.20.3 **Fixing Screws**

Mushroom-head steel roofing bolts and nuts complying with BS 1494 : Part 1 : 1964, shall be used to fix together adjacent sections of cable tray and/or accessories.

4.20.4 **Supports**

Cable tray shall be supported at centres not exceeding 1200mm, using galvanised channel steel brackets spaced from the fabric of the building.

4.21 Luminaires

4.21.1 General

The installation shall include all lamps, wiring, switches, contactors, controller supports and fixings necessary to complete the works as defined within the particular specification and drawings.

Unless otherwise specified, all luminaires shall be supplied and installed by the Contractor in accordance with the schedules. Each luminaire shall be rigidly supported.

Luminaires shall comply with BS 4533:1990 and BS EN 60598, and shall meet the requirements of the Electromagnetic Compatibility Regulations 1989. Furthermore they shall in their design and manufacture allow compliance in both operation and maintenance with the Electricity at Work Regulations 1989.

All luminaries, which are to be mounted in direct contact with the building fabric shall achieve an "F" rating in accordance with BS 4533.

All luminaires shall be earthed.

Unless otherwise indicated the enclosure of luminaires shall provide a minimum degree of protection of IP22 when located within buildings and IP54 when located externally.

Simple means shall be provided for the removal of diffusers for lamp replacement, and lamp holders arranged so that a lamp can easily be removed and replaced by one operative.

The control gear for discharge lamps, including fluorescent tube luminaires shall be effectively suppressed against radio interference and the circuit power factor shall not be less than 0.9 lagging.

The Contractor shall note the necessity of testing luminaires before erection since no extra labour charges or otherwise will be allowed for taking down, re-fixing etc., luminaires and lamps found to be faulty after erection.

4.21.2 Luminaire Construction

All materials, accessories and other related fitting parts shall be new and free from defects which may in any manner impair their character, appearance, strength, durability and function, and effectively protected from any damage from the time of fabrication to the time of delivery and until final acceptance of the work.

All luminaires shall be designed and manufactured, and all materials selected to provide a working life, of 20 years.

All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fittings from their mountings, or disassembly of adjacent constructions.

All castings shall be exact replicas of the approved patterns and shall be free of sandpits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of the metal castings in order that the finished castings will accurately fit in their designated locations.

All lamp sockets in luminaires shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fitting components. If adjustable socket positions are provided, sockets should be preset in factory for lamp specified. If different socket positions are specified for the same fitting, sockets shall be preset for each type, and cartons marked accordingly.

All luminaires shall be completely wired at the factory.

If ceiling system requires, each recessed and semi-recessed luminaire shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one-piece or constructed with electrically welded butt joints, and of sufficient size and strength to sustain the weight of the fitting.

Light leaks between ceiling trims of recessed luminaires and the ceilings will not be tolerated. If the luminaire is used in partially transparent ceiling, light leaks above the ceiling line will not be tolerated.

Yokes, brackets and supplementary supporting members needed to mount luminaires to carrier channels or other suitable ceiling members shall be furnished and installed by the Contractor.

Fittings for use outdoors or in areas designated as damp locations shall be suitably gasketed to prevent the ingress of moisture. Approved wire mesh screens for ventilation openings shall be provided.

For steel and aluminium fittings, all screws, bolts, nuts and other fastenings shall be cadmium or equivalent plated. For stainless steel fittings, all fastenings shall be stainless steel. For bronze fittings, all fastenings shall be stainless steel or bronze.

All luminaires and ballasts must operate within the temperature limits of their design and as specified by British Standards Institute in the applications and mounting conditions herein specified.

4.21.3 **Reflectors and Trims**

Reflectors, reflector cones and visible trim of all luminaires shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Client, completely clean.

All anodised parabolic cones shall be guaranteed against discolouration for a minimum of ten years, and, in the event of premature discolouration, shall be replaced by the manufacturer, including both the cost of materials and the cost of labour.

Aluminium reflectors shall be anodised finished specular, semi-specular, or diffuse as required.

As such the aluminium surface shall be treated to prevent iridescence. The finish shall be robust and capable of withstanding the design life recommended maintenance for removal and cleaning.

Plastic used for lenses and diffusers shall be formed of colourless motoral. Plastic lenses and diffusers shall be properly cast, moulded or extruded as specified, and shall remain free of any dimensional instability, discolouration, embrittlement, or loss of light transmittance for at least 15 years. All diffusers and lenses shall comply with the requirements of the Building Regulations regarding flammability and spread of flame.

Polystyrene shall not be used.

Glass used for lenses, refractors and diffusers in incandescent luminaires shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality.

Prismatic diffusers shall have the prisms located on the internal surface of the diffuser to minimise the build-up of dirt and aid cleaning of the external surface.

For exterior luminaires, use tempered borosilicate glass. For luminaires directly exposed to the elements and aimed above the horizontal with a radiant energy of 6443 watts per square metre or greater, use glass approved in BS 4533.

Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections, which may hinder the functional performance of the lenses.

All lenses, louvres, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

The method of attaching the diffuser/louvre to the body shall provide support during the installation/removal sequence.

All lenses shall be turned over to the Client, clean and free of dust.

4.21.4 **Supports and Fixings**

Fixing arrangements shall be sufficiently strong to ensure that the mechanical and electrical safety of the luminaires is not impaired by a reasonable additional load inadvertently imposed in the luminaires during installation or use.

Luminaires shall not be supported from ductwork, pipework or mechanical services.

Where luminaires are suspended from the structural slab they shall be supported by conduit or drop rods where necessary. All supports shall be straight and vertical and shall have 40mm threaded end for screw adjustment levelling. A minimum of four supports shall be provided for modular luminaires. A minimum of two supports shall be provided for linear type luminaires.

Threaded rod suspension shall comprise 6mm or 10mm cadmium plated steel, and shall be selected to provide a carrying capacity of not less than twice the weight of the complete luminaire.

Washers, nut and lock nut shall be provided top and bottom of rod. All cut ends shall be painted with zinc rich paint.

Where luminaires 1200mm or more in length are supported directly by the conduit system, they shall be fixed to two circular conduit boxes, both of which shall form an integral part of the conduit system.

Where the weight of a luminaire is supported by a conduit box or trunking shall be adequate for the purpose.

Where luminaires are supported from cable trunking they shall do so by means of proprietary clamps or brackets. All trunking utilised for this purpose shall be mechanically suitable for this application and installed in accordance with the manufacturers recommendations.

Luminaires shall not be supported directly from conduit boxes and trunking made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60oC or the suspended weight exceeds 3kg.

Luminaires shall be installed as indicated upon the drawings, and in a horizontal plane unless indicated otherwise.

Recessed luminaires shall be installed flush with the finished ceiling level.

All luminaires shall be installed in accordance with the manufacturer's recommendations.

The appropriate classification of luminaires shall be utilised, however, no luminaires shall be mounted on flammable surfaces.

Pendant luminaires shall be suspended at a height of 2050mm above finished floor level, measured to the lowest part of the luminaire, unless otherwise stated.

A pendant shall comprise a ceiling rose, flexible cord and lampholder.

Unless otherwise stated, the flexible cord shall be 0.75mm2 with 85 degrees C heat-resisting PVC insulation. Where the lampholder has a metal exterior, the flexible cord shall include a protective conductor connected to the earthing terminal of the lampholder and of the ceiling rose.

A tube pendant shall comprise a ball and socket cover to fit a circular conduit box, and steel conduit not less than 20mm diameter. At conduit entry to the luminaire, a backnut shall be used.

A chain suspension shall comprise a hook cover fixed to a circular conduit box and a chain having a load carrying capacity not less than twice the weight of the luminaire supported.

4.21.5 **Electrical Connections to Luminaires**

In all instances where cables enter luminaires through a hole in the body an appropriately sized grommet shall be used.

Terminal blocks for connection of the supply cables shall be adequate for the size of the conductors forming the loop-in wiring specified.

Each incoming terminal shall be marked to identify each conductor of each circuit.

A fuse holder and BS 1362 fuse shall be included within each incoming circuit phase connection. The fuse shall be rated as recommended by the manufacturer.

Where remote control gear is utilised it shall be installed within a separate lockable sheet steel enclosure providing the same degree of protection and finish specified for the luminaire. Maximum cable lengths between gear and lamp as recommended by the manufacturer shall be strictly adhered to.

4.21.6 **Final Connections to Luminaires**

For surface mounted fluorescent lamp luminaires fixed to conduit boxes or trunking the wiring shall be taken direct to the terminal block within the luminaire.

For surface mounted tungsten lamp luminaires fixed to conduit boxes, the circuit cables shall terminate at a connector block mounted within the conduit box. Final connections to the luminaire, including earth, shall be between the connector block and luminaire terminal block.
Where luminaires are suspended, recessed into the suspended false ceiling or mounted upon the suspended false ceiling, the conduit shall terminate adjacent to the luminaires on the soffit, slab or roof construction in a 2 amp, 3 pin plug in ceiling rose and cover assembly, complete with plug. Where connections to self-contained emergency luminaires are required, 4 pin plugs shall be utilised where the fourth pin is used for the unswitched permanent supply.

The final connection between high pressure discharge or fluorescent lamp luminaires and the 2 amp plug in ceiling rose described above shall be by means of heat resisting flexible cord.

Flexible cords used for final connections to luminaires shall be 2m length unless otherwise specified.

Luminaires connected by flexible cord shall be earthed by means of an additional earth conductor within the flexible cord. The earth terminal of the plug in ceiling rose shall have a cable connection to an earth stud within the conduit box or trunking as appropriate.

Luminaires mounted directly upon conduit boxes shall have an earth cable connection between the earthing terminal of the luminaire and an earth stud within the conduit box.

4.21.7 **Fluorescent Luminaires**

Unless specified within the particular specification, all fluorescent luminaires shall have a low loss, high power factor, switch start control gear suitable for use with T8 lamps.

Wound ballasts shall be of the low or ultra-low loss type and shall comply with BS EN 60920:1991 and BS EN 60921:1991.

Where electronic ballasts are specified they shall comply with BS EN 60924:1991 and BS EN 60925:1991, and shall have their output protected against short circuit and overload. Failed lamp detector shall be incorporated to shut down the output.

All starters shall comply with BS 3772:1990 and starter holders shall comply with BS EN 60400:1992. Starter holders shall be installed such that it is possible to change the starter

without the need to gain access to energised parts and that it is not necessary to remove any lamps.

All capacitors shall comply with BS EN 61048:1993 and BS EN 61049: 1993, and shall improve the inductive component of the luminaire to a minimum of 0.92 lagging.

The capacitor shall be of the self-healing dry foil type with a tolerance of +/-10% and shall contain a discharge device to ensure that the terminal voltage drops to less than 50 volts in no more than one minute after the supply is removed.

All luminaires shall incorporate a three way terminal block each way suitable for terminating 2 No. 4mm² cables, a cartridge fuse to BS 1362, power factor correction, capacitor and bi-pin lampholders, (push and return type).

The earth terminal shall be permanently and effectively connected to all exposed metalwork.

All luminaires will be supplied complete with louvres/diffusers, together with the appropriate suspension brackets for the ceiling to be installed in.

Diffusers, where fitted shall be of the acrylic or polycarbonate type and be non flammable.

Unless otherwise specified lamps shall be provided as Phillip Ltd colour 84, 3000k, white.

Fluorescent lamps shall comply with BS 1853 and BS EN 60081:1994.

4.21.8 **Spares**

The Contractor shall allow for 10% of each type of lamp installed as spares.

The spares shall be tested prior to being handed over to the clients representatives to ensure that they are in good working order.

4.22 **Emergency Lighting Systems**

Emergency lighting systems shall be installed as indicated on the design drawings and as described within the particular specification.

The systems are intended to provide temporary illumination to escape routes, walkways, selected areas and signage by means of separate, self-powered lighting in the event of failure of the normal lighting system.

The emergency lighting systems shall be of the maintained, or non-maintained category as appropriate, powered by generator or secondary batteries or self-contained luminaires.

All luminaires and associated equipment shall be ICEL approved and conform to the following British Standards.

4.22.1 **Self-Contained Luminaires**

i) Non-maintained, maintained and sustained.

The integral D.C. batteries and inverter unit shall be capable of supplying a load for the duration of not less than 3 hours, unless otherwise defined within the particular specification.

4.22.2 **Testing of Emergency Lighting**

The emergency lighting shall be tested via a key switches located adjacent to the distribution board in the electrical cupboard.

The Services Contractor shall allow for providing sufficient key switches to control each lighting circuit which has an emergency luminaire associated with it.

4.23 **Earthing and Bonding**

4.23.1 **General**

All materials used in the earthing network shall be of High Conductivity annealed copper of type, size and with protective covering manufactured to the appropriate British Standards.

4.23.2 **Standards**

All earth and bonding shall be carried out to ensure compliance with British Standards and all relevant requirements but not limited to these listed below:

- Electricity at Work Regulations 1989
- BS 7671: 1992 Requirements for electrical installations
- The Electricity Supply Regulations 1988 (as amended)

4.23.3 **Main Earth Network**

Where defined within the particular specification the main earth network shall consist of 9mm diameter copper coated, steel cored earth rods driven vertically into the ground.

The rods shall have internal screw joints and shall not be less than 16mm diameter. These rods shall be connected to each other and to any main earth test point using clamps-strand connections fixed to the head of each rod and earth cable. Earth cables shall be buried 750mm below ground level and rise vertically alongside each rod to enter the clamp. Buried cables shall be covered along their route with plastic cable route marker tape 300mm below ground level.

The resistance to earth of the electrode system shall not be greater than 0.5 ohms. Site tests are to be carried out when the rods are connected to ensure that the electrode system meets this requirement. Any deviation from the above shall be reported to the Engineer.

All earth rods will be installed via a concrete inspection pit. Such pits shall be made from purpose made concrete housing inscribed "EARTH ROD", fitted with removable inspection cover from external locations. For internal locations a puddle flange, pit frame, end cover and duct from pit to adjacent wall.

The Electrical Contractor shall provide full builderswork details for pit construction.
All connections shall be labelled “Safety electrical earth – do not removed”
Bonding of Incoming Services

The consumers earth terminal of the building shall be bonded to the metalwork of the incoming gas and water services and any other incoming services or rising mains such as ducting hot and cold water services or fire main services.

If there is more than one entry of any of the above services into the building then each entry must be bonded.

The bonding connection shall be made as near as practicable to the point of entry except in the case of the gas service where the connection shall be in the consumers side of the meter and must in all cases be in such a position that it will be easily accessible for inspection.
The bonding cable shall be LSF sheathed insulated cable coloured green/yellow enclosed in heavy gauge steel conduit, which is to be flushed into the wall where possible. This cable must be of continuous length and a minimum cross-sectional area of 6mm². The actual size shall be in accordance with the relevant BS 7671 tables.

4.23.4 **Main Earth Bars**

Where main earth bars are specified within the particular specification, they shall comprise of a suitably sized copper bar, equipped with clamps to accommodate the incoming and outgoing cables and tapes. The earth bar shall be affixed to the building structure by means of adequately sized phosphor bronze bolts and provided with insulated stand-off brackets.

The earth bar shall be identified by a suitable label marked Main Earth Bar and all connections labelled "Safety electrical earth – do not remove".

All exposed conductive parts of generators, transformers and main switchgear shall be connected to the main earth bar in accordance with the following table:

1 second current rating of switchgear (kA)	Minimum cross section of copper earth conductor (sq mm)
not exceeding 22	95
not exceeding 30	150
not exceeding 44	300

4.23.5 **Bonding of Cables**

All metal pipes or conduits in which the cables have been installed shall be connected to the earthing system. The joints, metal sheath and armour, if any, of the cables shall be connected to the main earthing system in an approved manner.

The Contractor shall ensure that cables are earthed in accordance with the following:

1. The sheath and armour of multicore paper-insulated cables and the armour of PVC insulated armoured cables shall be connected at each end to the earth bar or terminal of the associated switch or fusegear.

2. The sheath of main or sub-main multicore MIC cables shall be connected at each end to the earth bar or terminal of the associated switch or fusegear.

A brass or copper clip shall be fitted to the sheath immediately before the gland.

1. The sheaths of single core MIC cables used as main or sub-main feeders shall be bonded together and connected to the earth bar or terminal of the associates switch or fusegear, at each end. A brass or copper clip shall be fitted to the sheath immediately before the gland.

4.23.6 **Main Equipotential Bonding Conductors**

The Contractor shall install main equipotential bonding conductors to the following items, unless otherwise defined within the particular specification.

- All incoming gas main systems
- All incoming water main systems
- All incoming sprinkler systems
- Other metal service pipes and ducting
- All structural steelwork
- All incoming metal sheathed telephone cables – subject to the service providers agreement
- The lightning protection system

All the above main equipotential bonding shall be carried out with single core LSF insulated conductors of the size shown on the design drawings or detailed in BS 7671.

An engraved type label Red/White/Red with minimum character height of 10mm engraved "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE". This label is to be screwed to the wall or other suitable fixed structure in a prominent place.

4.23.7 **Supplementary Equipotential Bonding**

The Contractor shall provide a supplementary equipotential bonding system to all necessary exposed and extraneous conductive parts of the building, unless otherwise specified within the particular specification.

All cables shall be terminated directly into designated earth terminals or by propriety earth clamps. Such clamps shall comply with BS 951:1991, complete with a permanent label indelibly marked with the words "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE".

Generally items of equipment to be bonded shall have installed next to an empty conduit, flush or surface, terminating into a standard BESA box. The item being bonded shall be terminated to this point.

Where flexible conduit is used for final connections, earthing of equipment shall be carried out by a minimum of 4mm² 7/0.85 green and yellow LSF insulated copper protective conductor run through the flexible conduit and connected by crimped lugs to the earth terminal of the equipment being earthed an the earth terminal of the conduit should be crimped into a common lug.

The sizes of the supplementary bonding conductors shall be not less than 4mm² and shall comply with the requirements of BS 7671.

All electrical accessories mounted on metal boxes will have protective conductor installed between the accessories box and its earthing terminal.

At all supplementary equipotential bonding terminations, the Contractor shall install labelling as described below:

A durable permanent label with characters of minimum height of 4.75mm. with the words "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE". These labels are to be fitted adjacent to earthing terminals.

The extent of the works requiring bonding shall not be limited to those shown on the design drawings or listed within this section of the specification.

4.24 Telephones

The incoming telephone system shall be connected to the main earth bar via a 6mm² LSF insulated copper protective conductor served in a separate 25mm², metal conduit throughout its entire length. Any metallic sheath or armour of the incoming telephone cable shall be main bonded where it enters the building subject to the system providers agreement.

4.24.1 Lightning Protection Systems

The lightning protection system shall be connected to the main earth bar via 25mm x 6mm high conductivity copper tape (minimum size).

It shall be the Contractors responsibility to connect the lightning protection system to the main earth bar.

4.24.2 Testing and Commissioning

The Contractor shall give the Engineer fourteen days prior notification before commencing with the testing and commissioning of the earthing system.

The Contractor shall prove the following by means of inspection in conjunction with the engineers, but not limited to the following, the results of which shall be issued in a tabulated format by the Contractor.

1. Resistance and continuity of protective conductors.
2. Type of cable and type complies with specification.
3. Cross sectional area of earthing conductors.
4. Confirmation of identification of protective conductors is correct.
5. That all connections have been correctly made.
6. That the installation is fully labelled.

5.0 GENERAL MECHANICAL SERVICES MATERIAL AND WORKMANSHIP CLAUSES

The Contractor shall base his design, installation and tender price upon the following materials, plant and workmanship. Where options are stated herein, the Contractor shall refer to the "Particular Specification" for clarification. No deviation will be permitted unless agreed in writing prior to the submittal of tender. Where British Standards are referred to the latest standard shall apply including any subsequent amendments.

5.1 Pipework and Fittings

a) Classifications

Where pipework and fitting classes are referred to elsewhere in this specification, they shall mean the following:

i) Black Mild Steel and Galvanised Mild Steel:

Pipework to be of black mild steel "medium" grade to. BS1387 : 1985. Pipework to screwed up to and including 50mm and welded 65mm and above, screwed fittings to BS143 and BS1256 and BS1740. Butt welding pipe fittings to BS1965. Screwed fittings to be employed up to and including 50mm bore. Welded fittings and flanges to be employed on 65mm and above.

ii) Copper:

Pipework to be non-arsenical grade in accordance with BS EN 1057 1996 R250 Half Hard. Fittings to be "lead-free" capillary to BS864, Part 2:1986. All fittings shall be of metals not subject to dezincification.

iii) Polyethylene:

Underground pipework shall be medium density Polyethylene with either homogenous joints or fittings in accordance with the following standards.

Water Pipes to BS6572, fittings to BS5114.
Gas Pipes to BS7281, fittings to BS7336.

Water pipework to be suitable for potable water to Water Research Council approval.

Metric nominal sizes as stated on drawings, etc., are external diameters. Imperial equivalent sizes are internal.

iv) PVC:

Plastic pipework to be PVC in accordance with BS 3505, BS 4514 or BS 5525.

v) Soft Copper:

Soft Copper annealed pipework to BS EN 1057 1996 R220 annealed.

b) General

Unions shall be used on pipework up to and including 50mm on connections to all plant and equipment, and wherever difficulty in dismantling might occur. Unions to be malleable iron, navy pattern, with ground in bronze spherical seats for steel pipework and non-ferrous equivalent fittings for copper services.

Flanges shall be installed in lieu of unions on pipework of 65mm and above.

Reductions in pipe diameters shall be made by using one fitting only at locations such as reducing elbows, tees or couplings. All reductions in bore on horizontal pipework shall be formed eccentrically to prevent the formation of air pockets in the mains and/or facilitate drainage.

All branches from mains shall be taken from the top of the main wherever practicable and shall be made in such a manner as to allow for expansion and contraction in both main and branch.

No flanges joints or unions shall be used in in accessible ducts, trenches partitions or other such positions.

Joints shall not be made in the thickness of any wall, floor or ceiling. Where pipes pass through walls, floors or ceilings sleeves shall be provided. Where pipes are in trenches under the building or in other similarly inaccessible location, all joints shall be welded.

Long sweep fittings shall be employed at all times except where joints resulting from the use of these fittings would occur within wall or floor thicknesses. In these instances to comply with the spacing required below, short radius bends or elbows may be employed.

The Contractor shall install a special purpose made connection or a flanged joint with inert gaskets, washers and bolt sleeves where dissimilar metals are connected in a pipeline in order to prevent deterioration through electrolytic action and to conform to the local Byelaws where applicable.

The use of long screw connections and backnuts, square elbows or bushes is not permitted. Tees shall be sweep pattern, except where vent connections are taken off or where the use of a square tee would simplify or improve the pipework assembly. Bushed tees will not be allowed except by express permission of the Engineer.

Piping shall be cut clean and square with the axis of the pipe using a saw, pipe cutting tool or machine. The use of a bevel wheel cutter will not be allowed.

Where galvanised pipework is cut the reamered ends shall be coated with a good quality galvanise rich paint.

All burred and cut end of pipes shall be well reamered and filed to ensure that the full bore of the pipe is maintained.

All pipework to be installed with a continuous gradient to facilitate air venting and drainage. Levels are to be approved by the Engineer. All vertical pipes shall be plumb and all horizontal lines parallel with each other.

Clearance for pipes shall be provided as follows:

Walls	-	25mm
Ceilings	-	100mm

Floors	-	150mm or above skirting
Adjacent Pipes where applicable.	-	25mm between finished surfaces including insulation
Electrical Conduit	-	100mm

Where pipes pass through electrical switch rooms or over electrical equipment joints shall be welded and/or drip trays shall be suspended directly below and taken to a drain point.

Where pipework is to be insulated, it shall be fitted in such a manner as to allow each pipe to be insulated to the full circumference and also to allow clearance, after insulation, between the insulation and walls, floors, ceilings, other pipes or the insulation on other pipes, or any other surface in accordance with the dimensions stated above.

The Contractor shall take special care to prevent dirt or rubbish entering the open ends of all pipework during storage and erection. Should any stoppage occur in the circulation after the various systems have been put into operation because of non-compliance with this requirement, the Contractor shall attend and rectify the matter at his own expense.

Care shall be taken to ensure that threads are carefully cut so that the number of exposed threads is minimised.

Care shall be taken to avoid defacing of fittings. Spanners of the correct size are to be used on all hexagons. Fittings will be rejected if badly marked and the Contractor shall replace such at his own expense.

Welded joints shall be thoroughly cleaned with a stiff wire brush and painted immediately, and screwed joints shall have jointing compound removed.

Springs and sets shall be formed on a copper tube bender using the correct size formers, or if in small bore tube may be used by hand with a suitable spring insert. All such springs or sets shall be formed to a true radius and shall be free of deformation in bore or thinning of tube wall.

All final connections to sanitary fittings such as sinks, wash hand basins, WC cisterns, bib taps, kitchen equipment, etc., shall be carried out by the Mechanical Contractor unless specifically stated otherwise in subsequent sections of this specification.

All pipework shall be flushed clear of debris such as swarf, flux and oxides after completion of the erection of pipework. Where available all components such as heater batteries, heat exchangers and automatic control valves shall be bypassed during the flushing of the pipework mains. After verifying that the pipework distribution is clean these components shall be brought on line to be flushed. This simple flushing requirement may be effected by the use of the installations feed and expansion tank or by filling with the temporary mains water connection and subsequently draining in pressurised systems. The flushing requirement of this clause shall apply to all installations. Certain installations which are more sensitive to contamination will require full flushing procedures using a flushing tank, pump, self-draining pipework sections and full size air release valves. Where this procedure is required it will be specified in subsequent sections of this specification.

The construction, testing, flushing and draining of parts of the pipework installation may be required to suit the programme of works. Sectional working of this type is deemed to be included in the tender.

c) Pipework and Fittings for Various Services:

Pipework for various types of service shall be constructed from the class of tube and fittings stated below unless stated otherwise in the Particular Sections and this specification.

i) LTHW and MPHW Heating:

All heating circulation shall be based on the two pipe parallel flow and return principle unless otherwise stated or shown on BEC drawings.

Except where otherwise specified, pipework shall be run in medium quality black mild steel tube to BS 1387 and assembled where 50mm NB and below either exposed to view or in easily accessible locations with black malleable iron fittings. All heating pipework 65mm and above and all heating pipework where located in plant rooms, boiler houses, service ducts, roof spaces and inaccessible ceiling voids shall be assembled using medium grade welding fittings.

Heating open vents and heating cold feeds between the feed and expansion cistern and the circulation system shall be run in light gauge copper tube to BS EN 1057 1996 R250 Half Hard and assembled with Yorkshire copper capillary soldered fittings.

ii) Steam and Condensate:

Except where otherwise specified, pipework for steam and condensate shall be run in heavy quality black mild tube to BS 1387. Steam pipework shall be of all welded construction unless screwed fittings are specifically allowed, in which case wrought iron fittings to BS 1740 shall be utilised. Fittings shall be heavy quality in both cases. Condensate pipework shall be assembled as for Heating Installations.

iii) Chilled Water:

Except where otherwise specified chilled water pipework shall be run in black mild steel tube with black malleable iron fittings or welded fittings as detailed for Heating Installation in (i) above.

iv) Hot and Cold Water (Internal):

All pipework shall be run in light gauge copper tube to BS EN 1057 1996 R250 Half Hard and assembled with Yorkshire capillary fittings, having integral lead-free solder rings (YP range). End feed fittings shall not be used.

All flux materials used for soldering shall be WRC approved for use on Potable Water systems.

v) Gas Internal:

Gas pipework 28mm OD and below shall be run in light gauge copper to BS EN 1057 1996 R250 Half Hard and assembled with Yorkshire copper capillary fittings.

Gas pipework 32mm NB and above shall be run in medium quality black mild steel tube and assembled with screwed black, malleable iron fittings.

vi) Compressed Air:

Unless otherwise specified, compressed air pipework shall be run in galvanised heavy weight steel tube to BS 1387, jointed by means of galvanised malleable iron fittings with PTFE tape.

vii) Oil:

Unless otherwise specified, oil lines shall be run in black mild steel tube as detailed in i) above for Heating Installations, but employing jointing paste on screwed joints rated for use with oil.

viii) Refrigeration Pipework:

All refrigeration pipework shall be run in refrigeration grade degreased copper tube to BS2871 part 2 and selected from the industries imperial outside diameter size range in 1/8" diameter increments. The pipework shall be assembled using copper fittings with Eutectic or silver solder brazed capillary joints while under slight positive pressure from dry nitrogen. On completion the pipework shall be evacuated and pressure tested prior to charging with refrigerant.

ix) External Cold Water Mains:

Except where otherwise specified, underground external mains cold water shall be run in blue medium density polyethylene (MDPE) pipe, to BS 6572 up to 63mm diameter, by Yorkshire Imperial Plastics Limited, Wavin Industrial Products Limited. The pipe shall be assembled with electrofusion welded socketed polyethylene fittings. On larger size mains, over 63mm diameter, butt and saddle fusion fittings may be used. On smaller size mains Kuterlite 700 series gunmetal non-dezincifiable compression fittings may be used, at the Engineer's discretion. All jointing methods shall be to the manufacturer's recommendations, employing purpose made jointing rigs as appropriate.

x) External Gas Mains:

Except where otherwise specified, underground external gas mains shall be run in yellow medium density polyethylene (MDPE) pipe to ISO 4437 by Wavin Industrial Products Limited, Stewarts & Lloyds Plastics,. The pipe shall be assembled with electrofusion welded socketed polyethylene fittings. On larger size mains, over 63mm diameter, butt and saddle fusion fittings may be used.

On smaller sizes Kontite G600 series gunmetal compression fittings may be used, at the Engineer's discretion. The Contractor should include for this work to be undertaken by a British Gas approved contractor, unless he is able to amply demonstrate and certify his own competence to carry out the work. All jointing methods shall be to the manufacturer's recommendations, employing purpose made jointing rigs as appropriate.

xi) Chromium Plated Pipework:

Where chromium plated pipework is specified in such locations as shower areas or high standard hygiene areas, the pipework shall first be installed in copper tube and fittings and then removed, chromium plated at works by a specialist electric plating company and finally re-installed.

xii) Safety Valve Relief Lines:

Safety valve relief lines shall be run in heavy weight galvanised tube and taken to the plant room gully or if not available to within 150mm of the plant room floor.

xiii) Automatic Air Vent relief lines and Pressure gauge connections;

The vent release lines of automatic air units, connections to remote pressure gauges and lines for extension of air vents in equipment such as fan coils and heater batteries shall be run in 8mm diameter soft copper tube. The pipework shall be neatly clipped direct to walls using small copper saddle clips.

d) Welding:

Welding of steel pipes shall be by the oxyacetylene and/or metal arc method and shall be carried out in accordance with the relevant BS1821 and 2633.All welding shall be carried out by certified welders, who shall stamp all welds for identification purposes. Certificates and numbers shall be issued to the Engineer for approval. If requested by the Engineer, samples of the filler rod or electrodes to be used shall be submitted to the Engineer for approval before any work is commenced on site. The Engineer reserves the right to carry 'cutting out' welding tests on up to 5% of the welds on the installations. The Contractor shall include for remaking the joints where cut-out without extra charge.

All welded tees, branches, reducers, etc., shall be bevelled mitred joints fused by a penetration weld and finished off with a fillet weld of ample dimensions and penetration. All bends and tees shall be easy sweep branches made into the pipe except sizes 15mm and 20mm which must be made by drilling. 'Burning in' will not be permitted on these sizes.

Branch connections to mains may be employed where the sizes of the branch is two or more smaller than the sizes of the main. Generally sweep branches shall be made except for tees or headers or where a sweep fitting would cause air to be trapped. Profiled entries into pipework may be cut by flame but the cut edges must be filed smooth and all swarf and cuttings must be removed from the bore of the pipework before the fittings is offered up for welding.

Welded joints shall not occur within 2m (6 ft) of anchor points.

Welding of copper pipework using a bronze technique may be employed, the joints to be formed by swaging and a neat joint made, or by using welding fittings of approved pattern. All traces of flux shall be removed after the weld is formed.

Full protection shall be given to the building fabric and decorations by suitable fireproof mats.

Every precaution shall be taken to prevent damage by scorching or fire and provide two portable fire extinguishers for use by the Welder in any emergency. During all welding or cutting operations the Welder shall be accompanied by a competent assistant.

The Contractor shall include in his tender for the supply of all electric arc welding plant and equipment necessary to complete this Contract. The Contractor shall

also include for the cost of providing a supply of electricity for welding purposes by the use of mobile generating sets.

e) Pipe Supports:

All pipework shall be supported by brackets, hangers or clips of approved type.

All rawl, white metal or similar expanding fixings shall be provided and installed by the Mechanical Contractor inclusive of drilling the building fabric.

Pipework shall be supported so as to allow free movement for expansion and contraction, particularly at ends of runs, where a change of direction occurs. Swivel hangers shall be used as appropriate.

Main walls or partition walls, etc., where pipes pass through sleeves, shall not be considered as pipe supports.

Care shall be taken to ensure that the axis of the pipe is parallel with the axis of the pipe ring or hanger.

No structural steel shall be drilled for the passage of pipes unless instructed by the Structural Engineer. Patent type clips shall be used to fasten to the structural steel. Toggle bolts shall be used to fasten to the metal deck roofing systems.

Pipe supports shall be positioned at intervals not more than those given in the following tables:

Steel Pipework:

Nominal Bore	Horizontal Interval	Vertical Interval
15 mm	2.0 m	2.50 m
20 mm	2.0 m	3.00 m
25 mm	2.50 m	3.00 m
32 mm	2.50 m	3.00 m
40 mm	2.50 m	3.50 m
50 mm	3.00 m	3.50 m
65 mm	3.50 m	4.50 m
80 mm	3.50 m	4.50 m
100 mm	3.50 m	4.50 m
125 mm	3.50m	5.50m

Nominal Bore	Horizontal Interval	Vertical Interval
150 mm	4.00 m	5.50 m
175 mm	4.00 m	5.50 m
200 mm	4.50 m	5.50 m
225 mm	4.50 m	5.50 m
250 mm	5.00 m	5.50 m
300 mm	5.50 m	5.50 m

Copper Pipework:

Nominal Bore	Horizontal Interval	Vertical Interval
15 mm	1.20 m	1.80 m

22 mm	1.80 m	2.40 m
28 mm	1.80 m	2.40 m
35 mm	2.40 m	3.00 m
42 mm	2.40 m	3.00 m
54 mm	2.70 m	3.00 m
68mm	3.00 m	3.60 m
76 mm	3.00 m	3.60 m
108 mm	3.00 m	3.60 m
133mm	3.00 m	3.60m
159mm	3.00 m	3.60m

Plastic Pipework:

All plastic pipework should be supported in strict accordance with the manufacturer's recommendations. The following table should be used as a guide only.

Nominal Bore	Horizontal Interval	Vertical Interval
9mm	0.5m	1m
15mm	0.5m	1m
22mm	0.5m	1m
28mm	1.0m	1.5m
35mm	1.0m	1.5m
42mm	1.0m	2.0m

Supports shall be at closer centres if warranted by the arrangement of pipework, joint changes of directions, fittings and valves.

Where the ambient working temperatures exceeds 20ºC the support centres should be reduced. Continuous support is recommended where temperatures approach 60ºC.

Where one support carries more than one pipe of different sizes, the spacing shall be that specified for the smallest size of pipe. Vertical rising pipes shall be supported at a minimum of two points, and for 65mm and above, at the base to withstand the total weight of the riser. Branches from risers shall not be used as a support for the riser.

For steel tubing, clips shall be fabricated in malleable iron and on copper tubing, clips shall be fabricated from brass, copper or gunmetal. Supporting brackets may be by means of purpose made welded steel brackets, mild steel drop rods from floor plates or by surface mounted angle or channel iron and patent pipe clips, as appropriate.

Where mild steel pipework up to and including 50mm bore is fixed to solid walls, etc., it will be supported with malleable iron brackets of the screw-on or built-in type as manufactured by Crane Limited.

Where practical screw-on brackets Crane type 501 shall be used but where additional clearance is required, (i.e. for lagging, etc.,) brackets shall consist of malleable iron back plate fig. (515), rod and single fig. (429) or double fig. (5230) rings as appropriate.

Copper pipes shall be supported using cast brass brackets. Where pipes are exposed to view the brackets shall have a polished finish. Copper pipework adjacent to walls shall be supported on Academy board pattern brackets with screw fixing. Copper pipework positioned where space is required around the pipes shall be supported using a split ring, nipple and plate.

Copper heating pipework where exposed to view around the perimeter of residential flats in a domestic type application shall be fixed tight against the walls above the level of the skirting board by means of single piece, single screw fixing PVC or plastic clip complete with integral retaining clip around the perimeter of pipe.

Brass brackets shall only be fixed with brass screws.

Where a group or bank of pipes can be supported on a common support system this shall be employed. In some exposed locations this may however, be more unsightly than individual brackets and in such situations the Engineer's agreement must be sought prior to installation. Common support systems maybe of the proprietary type, FLAMCO, UNISTRUT, or similar, or purpose made employing portions of steel section, drop rods and split pipe rings. In all cases the pipe rings shall be of a material compatible with the pipe material.

In general low level pipes shall be clipped at least 25mm clear of skirting. No steelworks forming part of the building structure shall be drilled, flame-cut or welded, without prior consent by the Engineer.

Fixings into masonry shall be by screw into proprietary expanding plug, or by expanding bolt in preference to shot-fired fixings, which shall only be used by prior approval. Timber fixings shall be made with the correct size wood screw.

External supports shall be as approved by the District Surveyor, Architect or planning Authority as appropriate to the site concerned.

All hangers and supporting brackets must meet fully with the Engineers approval, and if specially fabricated, the brackets and other steelworks shall be painted two coats of red oxide before erection, and finished with one coat of black gloss.

f) Pipe Sleeves:

All pipes passing through walls or floors shall pass through a sleeve formed from sheet metal and built into the wall or floor, the sleeve finishing not less than 2mm (1/16") proud of the finished face of the plaster or finished floor. The annular space between the pipes and sleeves shall be adequately filled with Rockwool or similar to reduce noise penetration, maintain fire integrity, whilst allowing free movement of the pipe. Sleeves for steel pipes shall be made from galvanised sheet metal. Sleeves for copper pipes shall be in copper.

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

Where pipes pass through external walls of the building or trenches the Contractor is to install 'puddle pipes' of the same size and material as the pipework in which they are to be installed. Each puddle pipe shall consist of a

length of pipe, flanged at each end and with an undrilled flange midway between the two ends.

The whole to be thoroughly cleaned and steel pipes heavily galvanised after manufacture.

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

g) Expansion Bellows, Loops, Anchors and Guides:

Where possible, provision for expansion and contraction of piping shall be made for changes in direction. In other cases, adequate expansion loops or expansion fitting shall be provided. Expansion loops shall be shop manufactured and annealed after welding. Each leg of the loop shall be pulled cold to approximately 50% of the estimated expansion on each leg. Alternatively, stainless steel bellows expansion joints shall be provided, Guides shall be provided independently of anchors and expansion joints to prevent buckling. They shall be located approximately 600mm either side of expansion joints or as shall be determined by the manufacturer of the expansion device.

The Contractor must ensure that when installed the service is firmly guided over its total length upstream, and downstream of the expansion device, and that the exact amount of 'cold draw' is applied as recommended by the manufacturer. Where expansion devices are to be welded in the pipe line, care must be taken to protect the bellows or other components which can be affected by conducted or radiant heat. The Contractor must satisfy himself that the expansion device is capable of withstanding the test pressure to which the system will be raised on completion.
The Contractor will also satisfy himself that the imposed thrusts of the pipework under test pressure against anchor points will be absorbed by the anchor and the building without damage.

Pipe anchors shall consist of heavy steel collars with lugs and bolts for clamping and for attaching to anchor braces. Anchor braces shall be installed in the most effective manner to obtain the required bracing. No anchor braces shall be attached in locations where their installation will result in damage to the building construction. Details of anchors shall be submitted to the Engineer for approval before installation. On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be provided and preferably be welded to the pipework. Where it is impracticable to weld the anchors, the pipework shall be braced with at least two 'U' bolts being provided with sufficient thread to ensure an effective grip on the pipe. For copper pipework, anchors shall be provided by wide copper straps to secure the pipework, care being taken that in doing so the pipe is not damaged. The Contractor shall supply and install all cleats brackets and steel work required for the anchor pipes.

h) Pipe Grading:

All pipes shall be carefully graded to a rise or fall to facilitate the removal of air and for the complete draining of lines for maintenance purposes etc.

i) Air Venting of Pipework:

Air vents or air bottles shall be provided at all high points in the pipework. They shall be installed at the highest points of the sections which they are intended to vent.

All pipes, coils, radiators, convectors, cill line convectors and all pipework which requires venting shall be fitted with 7.5mm air cocks, unless otherwise specified. All convectors, cill line convectors, fan coil units, forced air heaters, concealed radiators, etc. shall have air vent points accessible from the outer casing.

Air bottles for low pressure systems shall be made from tube the same size as the main, approximately 250mm long where possible and fitted with a cap and 7.5mm air cock. Where the air bottle is fixed out of reach, a 7.5mm expansion tube shall be run from the cap to within 1.50m of the floor, terminating with a 7.5mm needle seated, key operated air cock.
Automatic air vents shall be used where indicated on the drawings and in the following situations whether indicated or not:

i) High level vent positions in boiler house and plant rooms on LTHW, MPHW, HWS and CWS services. The vent release line shall be taken to the plant room gully or drain, a drain point if available in the room or to within 150mm of the floor.

ii) The highest position of all LTHW, MPHW, HWS and CHW circulating mains in concealed locations in ceiling voids or roof spaces. The vent release line shall be taken to outside the building.

Air vents shall have gunmetal bodies, copper or stainless floats and guides and be connected by a non-corrodable lock-shield valve to the pipework tee.

j) Drainage of Systems:

All pipes shall be carefully graded to a fall to facilitate complete draining of lines for maintenance purposes.

On gas services, siphon boxes or pipes fitted with plugs shall be supplied and fixed in position necessary to facilitate drainage.
In addition, flushing points shall be provided in all water systems as recommended in the CIBSE Commissioning Guides section W for Water Services.

15mm diameter key operated cocks with hose unions shall be fitted at the lowest accessible points of all heating, chilled water, hot and cold water systems to ensure complete drainage.

Boiler, cylinders, etc., shall be provided at their lowest points with key operated gland cocks having hose unions. Alternatively, the emptying cocks shall be connected into a common 32mm nominal bore pipe draining visibly to waste over the nearest gully or sump.

k) LTHW & CHW - Venting and Draining:

All horizontal lines to be run with graded levels throughout or as otherwise specified. In general a vent point shall be provided at the furthermost end of each horizontal run or rise in the direction of flow, with a drain point at the opposite end. Dirt pockets shall be provided at the base of all vertical risers. Dirt pockets shall comprise of a square tee sized full bore extended down for 150mm

and fitted with a 25mm drain cock at the base unless the pipe diameter is less whereupon full line size shall be used.

l) HWS, TCWS, MWS - Venting and Draining:

All lines shall be graded so as to be self-venting to the draw of points and to allow every section of pipework to be drained down.

m) Gas Services - Draining:

All horizontal gas lines shall be run with a slight fall to the dirt/drain pockets or as specified elsewhere. All risers/droppers shall be fitted with dirt pockets at base. Each dirt pocket shall comprise a square tee, extended for 100mm and fitted with 25mm plug at the base unless the pipe diameter is less whereupon full line size shall be used.

n) Hydraulic and Gas Tests:

All hydraulic and gas testing shall be carried out prior to the application of any insulation. Hydraulic tests shall be applied after all entrained air has been eliminated from the system under test, the pressure gauge used shall be fitted at the furthest point away from the pump of the section under test. Test pressures to be 1.5 times the maximum working pressure.

o) Water Byelaws:

To ensure that the installation is acceptable to the relevant Water Authority, to prevent water wastage and/or contamination it is essential that the water services are installed in full compliance with the Water Byelaws issued by the relevant Water Authority, and the Water Supply (Water Fittings) Regulations 1999. Thus over and above any indication in this specification or on the drawings, the Contractor shall ensure that stopcocks, check valves, double check valves, and vacuum breakers are installed to satisfy the relevant section of the Byelaws, where applicable. In addition cisterns (except heating F & E tanks) shall be provided with all necessary fittings and accessories to comply with Model Byelaw 30 of WRc, and connections made in such a way to ensure adequate air gaps. Cisterns and tanks shall be properly supported, with access to ball float valves being at least the recommend minimum.

Special attention is drawn to the restrictions on types of ball float valves to be used, the necessity of service valves to each ball float valve, the fitting of water control devices on the supply to automatic flushing cisterns, and the various requirements associated with buried mains and their entry into buildings.

a) General

Valves shall be provided on all pipework wherever necessary to achieve proper isolation and regulation of the whole system. They shall be installed to isolate and balance every section of the pipework network including but not limited to the following locations.

i) To isolate each item of equipment.

ii) To isolate, regulate and balance the flow through each item of equipment and every section of the pipework network including sub branch mains, sub circuits, terminal units, and control valves.

iii) To isolate, regulate and balance the flow to any item of equipment supplied by or, to be connected to the systems, by others.

(Note: Should the equipment or plant not be connected up prior to balancing, temporary bypass connections and a double regulating valve shall be installed to achieve balancing).

iv) To isolate, and allow the removal of all control valves, flow meters, strainers, pumps, etc., and other similar pipeline ancillaries.

v) To isolate water services to all individual sanitary fittings or water service draw off points.

vi) To isolate immediately within the building all incoming services including Utility services.

vii) WRC approved stopcocks, gate or ball valves may be used for isolation within buildings on all mains or pressurised water services. Tank fed services shall employ gate type isolating valves.

Where authorised in subsequent sections of this specification small connections size 15mm and 20mm exposed to view in situations such as under wash hand basins, sinks and the like shall employ "Ballofix" or similar valves on MWS, HWS, and TCWS services.

viii) Where valves are shown as lock shield pattern or where the accidental closure or opening of a valve from its normal functioning position could cause harm to equipment or persons, then the valve shall be of the lockshield type with a bronze, chromium plated, or cast iron shield and a loose key or have a locking feature. In all other respects the valve shall be as specified for wheel type valves and shall be the equivalent Fig. number.

ix) Valves shall be either screwed or flanged in accordance with the Specification for the pipework into which they are installed, and shall be suitable for the working and test pressures of the system.

x) Where flanged valves are specified, flanges are to correspond to the appropriate BS specified in respect of the pipework.

xi) Non rising stem valves should be used wherever possible.

xii) All valves to be installed to manufacturers specification.

xiii) Unlined cast iron valves must not be used in copper pipe systems as it will lead to electrolytic corrosion of the cast iron, premature failure of the valve and impair the quality of the water.

5.1.1 **Valves for LTHW, MTHW, CHW and Water Services**

b) Isolating Valves

Valves up to 50mm bore shall be copper alloy, wedge gate type, with inside screw manufactured in accordance with BS 5154. They shall have a gunmetal or DZR copper alloy body, solid wedge and non-rising stem, with a screwed in

bonnet, high quality packing, adjustable gland and a die cast aluminium hand wheel

Valves on HWS, CWS and potable water must be WRc approved.

Valves shall be as manufactured by either Hattersley, Crane, Holmes and IMI (TA).

Valves 65mm bore and above shall be of the cast iron body, bronze or stainless steel trim wedge gate type as manufactured in accordance with BS 5150. They shall have a cast iron hand wheel, cast iron bolt on bonnet and stuffing box, a one piece gland, and a high quality gland packing to suit the applicable service media. Wedges shall be of cast iron with bronze or stainless steel facings/disc rings rolled into the cast iron. Valves shall have a non-rising stem of manganese bronze, brass, stainless steel or aluminium and valve seats shall have shouldered seat rings of bronze or stainless steel fitted into the valve body.

Isolating valves for services such as steam condensate, oil shall be similar the above, but supplied with suitable gland packing materials to suit the service concerned.

Valves for external water mains and incoming water supplies shall be capable of withstanding a test pressure of 2100 kPA and be constructed in accordance with BS5163.

c) Regulating, Measuring and Commissioning Valves

Regulation and Balancing of the systems shall be achieved by the installation of double regulating valves (DRV), and separate measuring station (MS) or a close coupled commissioning sets (CS), as detailed below.

Either a DRV and MS or a CS shall be provided on the return pipe from terminal units, branch or sub-circuit with an isolating valve on the corresponding flow. Manufacturer's installation details are to be strictly adhered to, regarding the minimum number of diameters of straight pipe run both upstream and downstream of the MS.

Any bypass pipework is to be fitted with a double regulating valve (DRV.).

Bypass pipework associated with 3 port mixing and diverting valves shall be fitted with a DRV.

d) Double Regulating Valves (DRV):

Valves up to 50mm bore shall be of the DZR/gunmetal oblique pattern double regulating type with screwed bonnet in accordance with BS 7350. They shall be constructed with a DZR/gunmetal stem, bonnet and disc, gunmetal or brass gland, regulating sleeve and a gland packing of high quality to suit the required service media. Valves shall be complete with a position indicator, lockable position setting device and characterised disk.

Valve 65mm bore and larger, shall be f the cast iron oblique pattern, double regulating type with bolted bonnet, in accordance with BS7350. The characterised disk can have an EPDM bonded coating to form the seat, a PTFE seat insert or be of cast iron with a bronze sealing face.

The gland packing shall be of high quality to suit the service media applicable and the valves shall be complete with a position indicator, lockable position setting device.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

e) Orifice plate type measuring stations (OP):

Orifice flow measurement devices from 15 to 50 shall be manufactured from DZR/bronze/stainless steel as a one piece item with integral orifice having a true square upstream leading edge. Both connections to be threaded to BS21 with a female inlet and male outlet, complete with 2 self sealing pressure test points.

Valves shall be as manufactured by Hattersley, Crame, Holmes or IMI (TA).

Orifice plates 65 to 300mm shall be manufactured from stainless steel with a true square upstream leading edge to sit squarely inside the bolt circle of BS4504 PN16 flanges and to be complete with 2 self sealing pressure test points.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

f) Commissioning Set (CS)

Valves up to 50mm bore shall be as per DRV's complete with close coupled orifice plate measuring stations.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

Valves 65mm bore and above shall be as per DRV's close coupled with an orifice plate measuring stations

Valves shall be as manufactured by Hattersely, Crane, Holmes or IMI (TA).

g) Non Return Valves (NRV):

Valves up to 50mm shall be the swing pattern check type with a screwed bonnet, metal to metal seat and constructed with a gunmetal body and copper alloy disc, cap, hinge and hinge cap all in accordance with BS 5154.

Valves shall have a direction of flow indicator cast onto the body.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

Valves 65mm bore and over shall be of the swing pattern check type with bolted cover, constructed in cast iron with a non asbestos gasket, gunmetal or cast iron disc with gun metal disc facing ring or rubber faced disc suitable for the pipeline media and a gun metal body ring all in accordance with BS 5153.

Valves shall be ad manufactured by Hattersley, Crane, Holmes or IMI (TA).

Note Non return valves shall be installed as per makers recommendations i.e. horizontal pipelines or in vertical pipelines for upward flow only, and with 6 diameters of straight pipe upstream 3 downstream. Where valves are mounted in turbulent flow conditions, i.e. on pump discharges, the maximum pipe/valve velocity should not exceed 2 m/sec.

Non return valves for use in DHWS systems in horizontal positions which are required to open under draw off condition shall be of the "Featherweight" balanced type with brass components of the "Senflux" type.

h) Drain Cocks:

Drain off cocks shall be installed at all low points in the pipework, on water chillers, boilers, thermal storage vessels etc.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

i) Bronze construction, fixed hose spigot, screwed BS21 male inlet connection and fitted with non metallic renewable washer.

ii) Bronze construction, hose union connection outlet, complete with cap and strap/chain screwed.

BS21 male inlet connection, with loose key operation.

i) Strainers:

Up to 50mm bore, strainers shall have bronze bodies, stainless steel basket with 0.8mm perforations and screw in brass cap, female BSP connections to BS21, and complete with a non asbestos gasket.

Strainers 65mm bore and above shall have cast iron bodies and covers, with stainless steel baskets with 1.6mm perforations and support screens. Body connections will be flanged to BS4504 and cover plates shall be bolted on complete with non asbestos gasket.

Strainers shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA) and fitted prior to the main plant i.e. boilers etc.

All strainers shall be sized full line size unless otherwise stated and provided with a pair of isolating valves.

Large strainers of size 65mm diameter and above shall be provided with a blow down valve in the cover (such as a hose union ball valve) to allow draining of the contents prior to dismantling for cleaning or flushing through.

j) Safety Valves:

Safety valves 50mm and under shall be bronze 'Pop' safety valves with flat seating surfaces precision lapped to give positive closure and with screwed ends.

Safety valves shall have the appropriate springs fitted in accordance with the operating pressure and the outlets shall be piped to a suitable discharge point to

low level. Safety valves shall be in accordance with BS759 :1984 and any subsequent amendments. All discharge pipework shall be laid to a continuous fall, and be galvanised steel or copper.

Hattersley Figure Number 320 or Nabic Fig 500 high lift.

k) Air Cocks:

Air bottles on low pressure systems shall be fitted with 7.5mm (0.25") air cocks. Hattersley Fig 425.

l) Automatic Air Vents (AAV):

On low temperature systems automatic air vents shall have an aluminium bronze body and bolted dome, stainless steel spindle, nickel alloy valve and seating, brass float, test cock and integral isolating valve. Screwed inlet 15mm and outlet 10mm as per Charles Winn and Company Limited, Type B, Sprix Sarco AE30CV or Crane D2001.

m) Gas Valves:

Gas valves shall be provided for isolation purposes on all plant connections and at branch connections.

Isolation valves for gas pipework 50 mm and below shall be DZR/brass ball valves with yellow lever suitable for use with natural gas as follows.

Valves shall be as manufactured by Hattersley, Crane, Holmes or IMI (TA).

One of the above isolating cocks shall be fitted to the gas inlet connection for each and every gas appliance within the building.

n) Radiator Valves (RADV):

Unless uniquely specified in the particular specification, the following manufacturers shall be used.

Holmes Valves Ltd
Peglar Ltd - Belmont II
HNH Ltd. - Delflo
Crane Ltd - Crusader
Hertz – TS'90 (available from Ellis Miller Ltd) hand wheel 900l non TRV.

Radiator valves shall be manufactured to BS 2767 with electro-nicked plated/chrome plated/polished finish body and white/ivory coloured wheel suitable for manual adjustment. Body to be angle reverse angle or straight pattern as necessary sized to match the pipework connection size unless otherwise stated.

o) Lockshield Radiator Values (LSRADV):

To be manufactured to BS2767 with electro-nickel plated/chrome plated/polished finish body and white/ivory coloured cap indicator. Body to be reverse angle, angle or straight pattern as necessary. The finish of the body and

lockshield cover must match that of the wheelhead valve or thermostatic radiator valve.

p) Thermostatic Radiator Valves (TRV):

To be manufactured to BS 7556 and En 215 for two pipe installation with electro-nickel plated/chrome plated/polished finish body and thermostatic head with numbered scale. Body to be reverse angle, angle or straight pattern as necessary. The size shall match the pipework connection unless otherwise stated.

Single pipe systems shall be provided with the manufacturer's alternative low resistance TRV. Thermostatic radiator valves shall be from the following manufacturer ranges:-

Peglar Ltd - Belmont II
HNH Ltd - Delflo TRV
Crane Ltd - Crusader D882 range
Danfoss Ltd - Randell
Hertz (available from Ellis Millar Ltd) – Hertz TS'90

5.2 **Ductwork and Fittings**

a) General:

All ductwork shall be constructed and erected in a workmanlike manner and when installed shall be free from sway, drumming or movement.

The ductwork shall be accurately lined up to ensure that ductwork running parallel to a surface is installed in line with that surface be it horizontal or vertical or both and that all ducts running parallel with each other are installed in line with each other.

No other equipment shall be hung off the ductwork supports unless prior permission is given in writing.

During erection, openings of ducts shall be sealed with plastic sheeting (heavy grade) secured with wide adhesive tape. Should there be a failure to comply with this requirement the contractor shall be required to thoroughly clean and disinfect all systems internally and externally (by a specialist if deemed appropriate by the Engineer), to the satisfaction of the Engineer and at the contractors own cost. Such cleaning shall be in accordance with HVAC ductwork cleaning guide TR17.

Ductwork will not be permitted to rest directly on portions of the building and where passing through walls etc. shall be mounted in a timber frame. The frame to be installed by the Main Contractor. Where insulation is to be fitted, the frame and duct position shall allow for sufficient space for the correct application of the insulation including continuity of vapour sealing.

Extract ductwork for kitchens, laboratories and specialist moist air extracts shall be installed to fall to drain back to the source.

Any low parts of ductwork or at the base of risers, flues, intakes, the ductwork is to be finished to collect all moisture etc. and a drain is to be fitted, piped to an adjacent gully.

Sheet thickness/stiffening etc. shall also be applicable to variable air volume systems. Pleating panel stiffening, will not be accepted and likewise internal standing seams unless prior permission is given in writing.

The first of two dimensions shown in drawings on rectangular and flat oval ducts indicates the size in the plane corresponding to the drawing view.

b) Ductwork Construction:

All ductwork shall be manufactured in accordance with the Heating and Ventilating Contractors Association DW/144-1988 Specification for sheet metal ductwork on low, medium and high pressure/velocity systems.

The pressure rating of the ductwork shall be as stated in the Particular Specification. The pressure stated shall be taken as being constant over that particular system or section of system described.

Leakage limits shall also be as described within the Particular Specification and the Contractor shall include for testing all high pressure ductwork as detailed in "Testing and Commissioning" herein.

All ducts shall be manufactured from hot dipped galvanised sheet to BS EN 10142:1991 Grade DX51D+Z, Coating type Z275.

All raw edges of ductwork seams and rivets shall be painted two coats of zine chromate primer prior to being despatched from works/prior to insulation being applied.

Supports shall be treated as per DW144 and where exposed i.e. not within false ceilings or risers, shall be inclusive of recommended follow on coats. The follow on coats to be to an approved B S Colour.

Similarly, steel flanges and steel stiffeners shall be finished to an approved BS Colour.

Circular ducts shall be of a spiral-wound construction unless stated otherwise in subsequent sections of this specification. Flat oval ducts shall be of spiral wound construction.

All ductwork in ceiling voids shall be constructed from sheet metal not less that 0.7mm thick to meet the fire resistance requirement of cavity barriers penetration. This requirement shall over-ride the minimum thickness of 0.6mm allowed by DW144 for small ducts.

Ductwork shall be sealed at the end of each daily period of construction to prevent ingress of dirt and waste prior to cleaning.

Ductwork shall be sealed at the end of each daily period of construction to prevent ingress of dirt and waste prior to cleaning.

c) Fittings:

The design of fittings shall be only these described in the various options of DW144.

Long bends shall be used wherever practical. Short bends with splitters shall be used only if long bends will not comply with the physical constraints of the area. Square bends with

turning vanes will only be permitted in locations where neither a long nor short bend would fit. All of these bends to be in accordance with DW 144.

Rectangular section 90° branches shall be taken off a straight duct and not a tapered section as per figures, 104 of DW 144.

Rectangular twin bends shall be in accordance with figure numbers 90 & 91. Rectangular twin bends as per figure 93 will only be permitted in locations where twin bends as figures 90 & 91 will not fit.

Angled offsets as per Figures 94 of DW 144 will not be permitted.

Shoes (leading edges) shall be provided on all branch connections and spigot connections to ductwork.

Tangential branches and segmented bends as per figure number 128 of DW 144 will not be permitted on circular ductwork. Radiased bends only should be used unless prior permission obtained in writing.

Secondary Branches on circular ductwork shall be as per figure 136 or 140 of DW 144.

Hand holes may be formed in ductwork for erection purposes, where necessary, but are to be kept to a minimum. Where hand holes are required they are to be backed with substantial galvanised rings riveted to the ducts and tapped for set bolts holding up to a 150mm diameter dished cover with air tight gasket. All flanged ductwork components such as batteries, dampers, etc., shall be provided with matching counter flanges and sealing gaskets.

d) Supports:

Supports shall be in accordance with Part 6 of DW 144 1998. All drop rods, etc., shall be galvanised and bolts/nuts and washers cadmium plated, being fixed to a mild steel angle or flat bearer as per Figs. 64 to 72 of DW 144. All angle bearers shall be painted in accordance with Clause 27.3.5 of DW 144 if not galvanised prior to installation and be finished with follow on coats where exposed to view to an approved BS colour.

No supports shall be taken direct from the roof decking and drilling or welding to the structural steelwork will not be permitted.

Where fixing to structural steel, the Contractor shall allow for a suitable patent clip fixing, etc., Lindapter. Where fixing direct to the flooring slab, the Contractor shall allow for drilling the slab to the structural Engineer's approval.

Where air is to be carried below ambient temperatures a vapour seal is necessary and supports shall be sealed where they penetrate the vapour barrier using an overlapping sheet of the same vapour seal as the main ductwork carried 50mm from the penetration and adhesive fixed.

All secondary steelworks to allow loads to be brought to suitable parts of the building construction shall be included in the tender. The Mechanical Contractor is directed to make his own assessment of the quantity, type and method of secondary support.

e) Flexible Connections:

Flexible connections of the impregnated glass fibre cloth type are to be fitted to the suction and delivery connections of all fans/air handling units and on connections to roof cowls/intake penthouses. These connections shall have a minimum fire resistance of at least 15 minutes when tested in accordance with Section 3 of BS 476. The flexible material shall be bonded to prevent particle migration and shall be flanged and held in place by a mating ring and backing plate having a minimum thickness of 3mm. The space between ductwork and plant shall be between 50mm and 250mm all in accordance with DW 144. Fig.82.

f) Test Holes:

Test Holes 10mm in diameter shall be provided immediately before and after all air handling plant heater and cooler batteries and at each branch connection, both on the branch and down stream side of the branch on the main duct, and either side of regulating dampers. All test holes shall be provided with a cover which shall be clearly identified.

g) Volume Control Dampers:

These shall be provided where necessary, to ensure proper balancing and regulation of the system. The dampers shall be of the air/shield type as manufactured by Actionaire Equipment Limited or Advanced Air (UK) Limited with adapter plates where installed in circular and oval ductwork. The dampers shall have stainless steel blades of aerofoil section mounted in a 16 gauge galvanised sheet steel fanged casing. The gears and bearings shall be totally enclosed, completely out of the air stream and constructed from Molybdenum disulphide filled flame retardant polyester.

h) Fire Dampers:

Fire dampers shall comply with BS476 Part B 1972 and be Loss Prevention council approved, to match the fire rating of the barrier in which they are installed. The fire dampers shall be constructed to the same standards of air tightness as the rest of the system and to suit the requirements of the Local Fire Authority. In the open position, the blades shall be suspended completely out of the air stream as manufactured by Actionaire Equipment Limited or Advanced Air (UK) Limited.

The dampers shall be installed complete with HVCA installation frames where installed in brick, blockwork or concrete walls. Where installed in cavity barriers or within openings which are to be fire protected by fire board etc. the ductwork contractor shall include for steel angle to fix the dampers to adjacent masonry/steel structure, and for applying fire protection to the steel.

Fire dampers shall be selected from the two manufacturer's ranges using the following models:

Fire Curtain Dampers (72°C operation + 200°C fusible link)

Actionaire Equipment Ltd	Advance Air (UK) Ltd	
Rectangular	Series 201	0160 - 10
Circular	Series 301	0160 - 20
Flat oval	Series 401	0160 - 30

Fire and Smoke Dampers (72°C operation + electric fail safe release)

Rectangular	Series 501	1240 - 10
Circular	Series 601	1240 - 20
Flat oval	Series 701	1240 - 30

NOTE:
Electrically resettable fire/smoke dampers will be noted within the particular section of the specification if required.

i) Access Panels:

Access panels shall be provided upstream and downstream of all heater/cooler batteries, at all plant connections and adjacent to fire and regulating dampers. Access panels shall also be provided at intervals of not less than 5m to all ductwork to allow mechanical cleaning. At least one access shall be provided between any two components which would obstruct free full brushing of the interior of the duct. Access doors shall not be less than 450 x 450mm clear opening unless the duct dimension dictates otherwise. In this case the access door will be as large as the duct permits to provide the necessary access.

Access panels shall be as manufactured by Actionaire Equipment Ltd or Advanced Air (UK) Limited, of the double seal type with single retaining catch and locking screw. Where ducts are thermally insulated, the access door frame shall extend beyond the face of the duct by a measurement equal to the thickness of the insulation and arranged so that the insulation and finish be dressed into the frame.

j) Flexible Ductwork:

All flexible ductwork used on supply systems shall be of the pre insulated type with vapour seal. Flexible ductwork used on extract systems/recirculation systems may be uninsulated. Joints to rigid ductwork spigots shall be made by one of the methods described in Clause 25 of DW 144. The lengths of flexible ductwork shall be kept to a minimum, in no case being longer than 2m and shall meet the standards of air tightness of the remainder of the ductwork installation; all as DW 144. Flexible ductwork shall be of metal construction as clause 25.2.1 of DW 144.

k) Acoustic Ductwork Insulation:

Attenuators shall generally be positioned immediately adjacent to the noise generating equipment which they are to attenuate in order to avoid noise breakout. Where physical reasons prevent the attenuator from being situated in the best position adequate precautions shall be taken to prevent noise breakout. This shall take the form of external acoustic insulation applied to any duct potentially emitting direct breakout and two thirds of the associated attenuator. The thickness and density of the external acoustic insulation shall be sufficient to

meet the noise levels generally specified for various spaces in Section 2 of The BEC Specification.

When ducts and attenuators are already required to meet thermal insulation requirements the acoustic insulation may be combined with the thermal insulation or laminated as an additional treatment. The combined effect must meet both thermal and acoustic performance requirements and maintain vapour barrier if needed.

l) Sealants and Sealing Gaskets:

Sealants shall be of the liquid/mastic type which permanently retain adhesion and elasticity throughout a temperature range of 0oC to 70oC. The sealant shall be applied with a brush or gun and shall completely seal the joint. The ductwork must not be pressurised until the sealant has cured. The jointing between angle flanges shall be suitable gaskets or mastic sealant. The gasket shall be no less than 3mm (1/8") thick for ducts of up to 1.0mm (20 B.G.) sheet thickness or less than 4mm (3/16") for ducts up to 1.2mm (18 B.G.) sheet thickness. Before application all surfaces shall be thoroughly cleaned and the sealant applied in accordance with DW 144.

m) Connections to Builders work:

Where metal ducts and fan inlets and outlets connect to builders-work these shall be in accordance with DW 144, Clauses 28 for connection into timber frames.

All ductwork shall be subjected to thorough mechanical cleaning at the end of the construction process or in stages as the programme of works requires. TEP may wish to witness the cleaning. 48 hours' notice in writing shall be given of the start of cleaning. The cleaning shall consist of hand and power rotary brushing of the whole of the internal surfaces of the ductwork in conjunction with vacuum collection of the waste from the process.

In addition to the above mechanical cleaning certain installations may require biocide cleansing with spray equipment. This will be specified in the particular section if required.

n) Ductwork Drawings:

Detailed shop drawings of the proposed ductwork installation shall be prepared by the Contractor and duplicate copies submitted to the Engineer for approval prior to manufacture.

Such approval will be in principle only and will not relieve the Contractor of his responsibilities for taking site dimensions and ensuring correct fit, air tightness and operation of the installation, or from any other responsibilities and obligations under the Conditions of Contract.

The responsibility of ensuring that the ductwork, grilles, etc., will fit into the space allowed for them will remain with the Contractor. Architectural and structural details are to be taken into account in conjunction with the Engineer's drawings.

Generally, where mains pass ductwork, the ductwork is to take preference and the pipework is to be set around the ductwork. However, if the mains are large

compared with the ductwork and it would be of financial advantage to set the ductwork, then this is to be done, but such sets are to be shown on the above detailed drawings that are submitted to the Engineer. No extra will be entertained for duct sets to pass pipework.

o) Grilles:

All grilles shall be provided with integral opposed blade volume control dampers unless otherwise stated.

Each grille shall be provided with a sheet metal boot for connection constructed to the general ductwork standards described above.

All grilles shall be Epoxy painted gloss finish to a BS or RAL colour to be advised prior to ordering.

5.3 **Thermal Insulation**

a) General:

The Contractor shall supply and install thermal insulation, acoustic insulation and trace heating as detailed in the particular specification and in accordance with the following.

The Contractor shall check the building and setting out dimensions before fabrication of insulation and cladding materials is started, by reference to structural, architectural and services drawings. Where necessary the Contractor shall take site dimensions to confirm or enlarge upon the information on the above drawings.

In situations where the building is not available for site measurement the Contractor shall make sufficient allowances for building tolerances, in order that fabrication may proceed, so that the insulation can be readily modified on site if necessary.

The Contractor shall make careful selection of materials to ensure that they are in all respects eminently suitable for the purposes for which they are to be used. Where a quantity of materials or items are used they shall be from the same manufacturer.

All materials shall be packaged and stored in a suitable manner so as to protect them from damage or deterioration before fixing.

Each pipe shall be insulated separately and adjacent parallel pipes shall not be married together with insulating material.

The standard of workmanship for the works must be of the best standard produced by work people completely experienced in the classes of work which they are undertaking, and shall conform to current BS and COP recommendations.

All insulation materials used throughout the Contract shall be mineral fibre or phenolic foam unless otherwise stated; and all vapour sealing and other finishes shall be incombustible not less than class 'O' faced.

The thicknesses of thermal insulation shall, in all cases, comply with the minimum requirements laid down by the latest British Standards (BS5422:2001) and Building Regulations and the table within this Specification.

All materials must satisfy the requirement of The Fire Officer and Local Authority.

All connections on Vessels shall project at least 25mm (1") clear of the finished surface of the lagging.

All insulation shall be applied so as to give a smooth and uniform surface. All rigid sections shall be concentric and to be accurately matched for thickness. Steps and undulations in the surface will not be accepted. Any sections or slabs having damaged ends or edges will be rejected.

All insulation shall fit correctly to the surface to be covered and all slabs and sections shall be built up with closed edges butted mitred, chamfered or shaped as necessary.

In considering the thermal efficiency, the effect of any hard setting finishing coats or any other finish shall not be taken into consideration.

No insulation shall be applied until pipes, plant and ductwork have been tested. Attention is drawn to the provision for painting of pipes, and trace heating (specific areas) prior to the application of any thermal insulation.

The Contractor must ensure that work covered by this Contract is carefully programmed with the other works to ensure that damage to finished work does not occur.

All insulation applied to any plant shall be neatly cut around all manufacturer's names and test plates to leave these visible. All insulation applied to any ductwork shall be neatly cut around all dampers, test holes, thermometers, etc., to leave accessible.

Insulating materials shall be carefully dressed around pressure tappings, drain cocks, thermometer tappings etc., and, where applicable, vapour barrier materials shall be continued over exposed insulation in order to maintain a vapour seal.

Cladding shall be neatly cut around such projections from pipework and ductwork and suitable grommets inserted to provide a neat finish to the work.

All flanges, unions and valve bodies except where on chilled water or in external ducts or fully exposed weather conditions shall be left bare, unless stated otherwise.

The Contractor shall allow for the application of one coat primer paint to black mild steel pipework on fittings, prior to insulation or paint work finish, as applicable.

No insulation or finish paint shall be applied to pipework, valves or fittings, brackets, drop rods or support steels until these components have been finally positioned and painted with primer, where applicable.

All metal parts of valves supports, etc., projecting beyond the insulation of cold or chilled water pipework shall be painted with anti-condensation paint to an approved BS colour, as manufactured by Seculate Ltd and approved.

Insulation, cladding and paint work shall be applied in accordance with the manufacturer's recommendations.

Mastics, sealants, adhesives and fixatives shall be applied in accordance with the manufacturer's recommendations, and shall also be approved by the manufacturer of the components to which they will be applied.

In addition the Contractor shall provide the following:

1. Non-compressible insulation spacer blocks within the supports for all chilled water pipework to enable continuous insulation and vapour seal. The spacers may be made from hardwood, phenolic or rubber materials.

2. Installation of spacer strips within the supports for insulated ductwork to enable continuous insulation vapour seal and cladding finish. The spacers may be made from hardwood, phenolic, or rubber materials.

Thermal insulation and finishes shall be applied in various situations as follows:

b) Supply Ventilation Ductwork, on Air Conditioning Systems - Concealed Areas:

This section applies to all supply ductwork, including flexible connections, grille plenums, fan coil unit plenums and fan coil unit discharge ductwork.

Rectangular supply ductwork shall be insulated with mineral fibre Rigid Duct Insulation Class 'O' foil faced finish, 50mm thickness, density 48kg/m³ or CFC free phenolic laminates with inner facing density 40Kg/m² and class O foil faced external finish.

The insulation shall be cut to fit on site so that the top and bottom pieces overlap the sides. The insulation shall be bonded to the ductwork by means of a suitable adhesive, applied in accordance with the manufacturer's recommendations. Insulation on the underside of ducting shall be additionally secured by means of additional hangers at 300mm centres to eliminate sagging. All insulation slabs shall be closely butted together.

Circular and flat oval ducting shall be insulated with mineral fibre. Flexible Duct Insulation Class 'O' foil faced finish to 50mm thickness or CFC free phenolic laminated slabs slotted for use on curved surfaces.

The insulation shall be wrapped around the ductwork and bonded with a suitable adhesive, applied in accordance with the manufacturer's recommendations. Additional restraining straps/fixings shall be used to secure the bonded insulation to the circular and oval ductwork as necessary, ensuring that the vapour barrier is not penetrated as a result of this application.

All insulation joints shall be sealed by means of 'dead soft' Class 'O' matching foil faced self-adhesive tape 100mm wide. Any exposed edges of the insulation and any other points where the covering is penetrated shall be sealed with a proprietary sealant.

In order to maintain the continuity of the vapour barrier, where the hangers penetrate the finish it shall be sealed with a proprietary sealant, together with any exposed edges and vapour barrier penetrations.

The vapour seal shall run through all supports etc., to prevent any possibility of cold bridging causing condensation. Spacer bridges shall be used on the ductwork supports to enable the vapour seal to be continuous.

Ductwork flanges shall be insulated with a minimum insulation thickness of 15mm.

The whole of the casing of all Volume Control dampers shall be insulated.

Where pitot static tube holes are drilled for test purposes, the insulation shall be finished neatly around the holes and the hole identified and plugged. The vapour seal shall be continued once tested and balanced, across the plug and the plug identified.

The insulation shall be carefully trimmed around access doors and damper operating mechanisms etc., so that they are accessible. All access doors shall be separately insulated.

The bare edges of insulation shall be tucked into an aluminium angle channel around the item requiring access. The channel shall be fixed to the ductwork with suitable adhesive.

Fresh air inlet ductwork shall be insulated as described above in this section.

c) Supply ductwork on "Heating only" ductwork systems:

Supply ductwork on "heating only" systems shall be installed as (b) above, except that Spacer supports and vapour sealing are not required,

d) Extract Ductwork:

No thermal insulation required unless specifically specified within the particular specification.

e) Recirculation Ductwork:

Recirculation ductwork shall be insulated in accordance with (c) where not within the area being served or its associated false ceiling. To be insulated in accordance with (a) were passing through special environments as called for in the particular specification.

f) Aluminium Cladding to Ductwork:

Subject to confirmation in the Particular Specification, ductwork in plantrooms, maintenance areas, and where specifically identified in the Particular Specification and/or drawings, the thermal insulation shall be as per (a) to (e) as appropriate and the entire insulation shall then be covered with 20 gauge hammerclad aluminium sheeting. Joints shall be hidden and arranged in an orderly manner, and where possible be arranged at natural junctions (i.e. corners, etc.) to present the cleanest possible aspects of the finished work.

All access panels and trimming of the aluminium sheeting for access doors, VCD handles, test holes, control sensors, etc. shall be trimmed/finished with aluminium angle. Sheeting shall be pre-drilled for riveting or screwing so as not to damage the vapour barrier.

g) External Ductwork:

All external ductwork shall be as per (f) with all aluminium cladding joints to be neatly sealed with a clear silicone mastic to ensure the whole is weatherproof.

Alternatively, as directed in the particular specification or as agreed with the Engineer, the insulation, shall be as per (a) to (e) as appropriate, finished with layers of glass fibre mating and resin to produce a rigid, strong and weatherproof finish. The whole shall be painted with undercoat and 2 top coats to an approved B.S. Colour.

h) Internal Chilled Water Pipework:

Internal chilled water pipework shall be insulated with rigid mineral fibre or CFC free phenolic foam preformed sectional insulation, securely fixed and finished with foil faced finish Class 'O' sheeting with overlaps neatly pasted down and vapour sealed.

Supports shall be provided with rigid hardwood, phenolic or rubber bridges or proprietary inserts by Stuart Forbes (Grips Units) Ltd around the circumference of the pipe and the vapour seal continued through the supports.

Bends and fittings shall be formed from mitred and trimmed sections cut to ensure that a good contact with the surface to be insulated is made, and that the true shape of the fitting is maintained.

Straight sections of insulation shall be applied in lengths up to 1.2m in half segment sections, adjoining sections being firmly butted together and joined with minimum 100mm wide, self-adhesive foil faced finish dead soft aluminium foil tape, applied over a clean surface and firmly pressed down.

Aluminium end caps shall be fitted to finish all ends of sectional insulation. The entire vapour barrier and insulation shall be continuous throughout all pipes passing through walls, floors and where brackets, hangers, flanges or unions occur, and considerable care shall be taken to ensure that all joints in the surface are properly sealed so that the vapour seal is maintained.

Under no circumstances will a break in the vapour seal be permitted.

Strainers, valves, drain cocks including control valves, check valves etc., and flanges and fittings unions 50mm diameter and under shall be insulated throughout as per the pipework. Fittings 65mm diameter and over shall be insulated with denso paste to maintain the vapour seal whilst enabling the valves to operate. The paste thickness shall not be less than 25mm at any point and shall have scrim cloth embedded to ease removal and replacement during maintenance. The whole shall then be insulated with a larger section of rigid pipe insulation with ends vapour sealed and finished with aluminium end caps neatly taped.

Exposed sections of valves and handles outside the insulation shall be painted with anti-condensation paint.

The particular sections of the specification may alternatively call for detachable aluminium valve boxes around valves and other fittings. These shall be provided with quick release buckles and internally lined with 50mm thick mineral fibre. All edges shall be formed by folded seams. The boxes shall generally be as described in section (l).

i) Internal L.P.H.W. Pipework

All LTHW pipework shall be insulated, including mains and sub-circuits which run within rooms etc. Only tails, final connections to individual terminal units shall be un-insulated.

Insulation shall generally be as (h) above accepting that it is not essential to maintain a vapour barrier throughout.

The insulation shall be continuous except where brackets or rollers, valves, unions, flanges, etc., are encountered.

Where rollers are encountered the insulation shall be stopped 25mm short either side and finished with aluminium end caps. Where brackets are encountered, the insulation shall be carried through over the bracket.

End caps shall be of sufficient size to extend from the outside of the insulation to the outside of the pipework.

Valves, strainers and flanges etc., shall be uninsulated, unless specifically called for in the particular specification when the insulation shall be carried through with oversized section.

j) Hot Water Service Pipework:

Shall be insulated as (i).

k) Mains and Cold Water Services:

Shall be insulated as (h)

l) Aluminium cladding to pipework:

Subject to confirmation in the Particular Specification, pipework in plantrooms, maintenance areas, and where specifically identified in the particular specification and/or drawings, the thermal insulation shall be as per (h) to (k) as appropriate shall then be covered with 20 gauge hammerclad aluminium sheeting.

The cladding shall be continuous except where insulation terminates at flanges, valves etc. Where this occurs the end shall be fitted with a polished aluminium end cap fixed over the aluminium cladding. These end caps shall be of sufficient size to extend from the outside of the cladding to the outside of the pipework.

Bends, tees, and other junctions shall be formed using purpose made, pattern cut sections.

Joints shall be hidden on the rear, or underside of low level pipework and on the topside of high level pipework in order to present the cleanest possible aspects of the finished work. Traverse joints shall be made using self-tapping stainless steel screws of aluminium pop rivets. All traverse joints shall line up exactly with those joints on any parallel runs of pipework wherever practicable.

All valves, strainers, flanges and unions on all services shall then be enclosed with 20 gauge polished aluminium boxes formed to suit the shape of the unit being insulated.

Mineral fibre mating shall be used in lieu rigid sections. CHW, MWS & CWS valves shall also be covered with denso paste as per (h).

Rubber compression strips shall be fitted to edges of the cladding on boxes, between the box 'gland' and the outer cladding of the adjoining work, in order to close any gaps between the two.

Boxes shall comprise of two sections, these being hinged on one side and fastened together on the opposite side by a quick release catch of the toggle hook pattern. PK screws or any other form of fixing will not be permitted. Seam joints in the construction of the box shall be lapped and riveted or alternatively lock-formed and pulled down flush with the finished surface. The Contractor shall allow for insulating in common sectionalised boxes valving arrangements which will occur in close sequence.

m) Isogenopak cladding to pipework:

Subject to confirmation in the Particular Specification, pipework in plantrooms, maintenance areas, and where specifically identified in the particular specification and/or drawings, insulation shall be covered with Isogenopak sheeting. The sheeting shall be applied as per "(l) Aluminium cladding" except for end caps which shall match the Isogenopak colour/material. Valves etc. shall be enclosed in 20 gauge polished aluminium boxes as section (l).

n) External Pipework where exposed and in Trenches:

Insulation shall be as per (h) to (k) as appropriate, and covered with 0.8mm Polyisobutylene sheeting secured with all joints lapped and welded by means of the suppliers recommended solvent.

All valves (including heating and hot water services) shall be insulated with denso paste and oversized fibreglass insulation as appropriate, and the whole wrapped in Polyisobutylene.

Alternatively, valve boxes as described in section (l) may be required if stated in the particular section.

All external pipework shall be electrically trace heated prior to application of any thermal insulation (see r).

o) Refrigeration Pipework:

All refrigeration pipework (suction and discharge) shall be insulated with "Armaflex" Class O where internal and Class 1 where external. External Armaflex shall be painted with two coats of proprietary Armaflex paint. The paint shall be applied immediately after the application of insulation to prevent degradation due to the ultra violet element of daylight

All joints (longitudinal and end) to be welded with the appropriate solvent, and all bends to be mitred and glued.

p) Thermal Storage Vessels:

Thermal storage vessels shall be insulated using 100mm thick insulation, applied in the same manner as for circular and flat oval ducting. The insulation shall then be covered with 20 gauge polished aluminium sheeting applied in the same manner as for ductwork. Joints shall be hidden and arranged in an orderly manner to present the cleanest possible aspects of the finished work. Care shall be taken to ensure that the integrity of the vapour barrier is maintained throughout the insulation of chilled water storage vessels.

q) Cold Water and F & E Tanks

All cold water storage tanks of the type which are not pre-insulated and all feed and expansion tanks shall be insulated with phenolic foam or mineral fibre, rigid duct insulation class 'O' foil faced, 50mm thick in a similar fashion to rectangular ductwork insulation specified in Clause 3.M.5 b).

Exposed edges of cut slabs shall be sealed with matching class 'O' foil faced tape or sheet overlapped and sealed with proprietary sealant. Each panel of the insulation shall have buff joints to adjacent panels to allow section by section removal. The cut and edge sealed panels shall be strapped into position using galvanised metal flexible bonds and buckles to allow removal. The face finish shall be reinforced at points of contact where straps could penetrate the finish. The top of the tank shall be insulated in the same way but with trimmed provision for vent penetrations and connections.

r) Heater and Cooler Batteries Located in Distribution Ductwork:

All heater and cooler batteries shall be insulated as for supply ductwork with the addition of purpose made insulated aluminium header boxes for pipework headers. Care should be taken to ensure the integrity of the vapour barrier is maintained throughout the insulation of the cooler batteries.

s) Electrical Trace Heating:

All external pipework, plus pipework in unheated areas where there is a risk of freezing shall be electrical trace heating throughout prior to the thermal insulation being applied. All trace heating elements shall be of the energy efficient self-regulating type as manufactured by Raychem and known as "WinterGard". The self-regulating trace heating tapes shall comply with BS6351.

The trace heating tapes shall withstand the maximum temperature under operating conditions. All trace heating tapes shall be capable of design to maximum circuit length equal to 150m.

The Contractor shall base his selection of trace heating elements on an ambient air temperature of –20°c and in addition a wind speed of 10 metres/s where pipework is exposed. All trace heating circuits shall be controlled via an air sensing thermostat. All trace heating cables shall be installed, tested and terminated in strict accordance with the manufacturer's instructions.

The manufacturer shall make available to the contractor a trained and capable field engineer or technician for providing installation training and technical design support. Each heater shall be provided with the proper fittings for the field connection to the system without the need for further procurement of special fittings or wiring devices. Each trace heating circuit shall be protected electrically by use of type 3 or type 4 circuit breakers to BS3871 Part 1 1965 (1984) or equivalent in combination with residual current devices, and sized in strict accordance with manufacturer's instructions. All works should be carried out in accordance with the IEE regulations for electrical installations (16th edition).

t) Schedule of Insulation Thickness:

The thickness of pipeline thermal insulation shall be in accordance with the Tables in the British Standards for various services. The thickness shall also apply to all vents, feeds and ancillary pipework which is required to be insulated.

Acoustic Insulation:
Where shown on the drawings, external acoustic insulation shall be applied as follows:
Type = Flexible mineral-impregnated PVC material.
Code = FBM 0916, 9mm thick 16kg/m3.
Minimum acoustic performance.

Frequency	=	125	250	500	1Hz	2Hz	4Hz	(hz)
Insertion loss	=	22	25	30	35	37	49	(dB)

The material shall be applied with suitable adhesive, and on duct surfaces in excess of 600mm, additional pins and ties are required. All joints shall be overlapped or butt joints over-welded. The insulation shall extend over two thirds of the length of any associated attenuator to ensure breakout control.

The above specification shall be regarded as a minimum. Where higher performance is required to meet building noise levels generally additional thickness and higher density shall be employed in conjunction with thermal insulation and vapour barrier if appropriate.

v) Quality Control:

The Contractor shall arrange for a sample section of each type of insulation finish to be completed and examined for standard of workmanship prior to proceeding.

5.4 **Circulating Pumps**

The Contractor shall supply and install pumps as required. Each pump shall be fitted with , pressure gauge tappings on the suction and discharge branches, and shall be driven by totally enclosed fan cooled squirrel cage induction motors to British Standard metric suitable for operation on 415 volts, 3 phase, 50Hz or 240 v 1 phase 50Hz electric supply. The pump casings shall be cast iron and the impellers for each pump shall be

manufactured from stainless steel to BS1449 304 516. Pumps on hot water supply shall have gunmetal casings and impellers.

The pumps, where floor mounted in Plant Rooms external to the occupied building shall be mounted on concrete bases provided by the builder. The Contractor shall supply and install anti-vibration mountings for all pumps.

Where the pumps are located in roof plant rooms over occupied areas, the Contractor shall include for supplying and installing inertia bases and spring mounting hangers as recommended by the pump supplier to ensure compliance with the specified noise levels.

All the above as supplied and manufactured by Pullen Pumps Limited, or Holden & Brooke or Grundfos or as specified.

Pressure gauges are to be fitted to each pump suction and discharge connection with isolating cocks.

Each pump shall be supplied complete with BSTE flanges and counter flanges and shall run at 1450 RPM unless otherwise stated.

Where indicated in the Specification as duplicate run and standby pumps, the pumps shall be manufactured and supplied as a duplicate pump set complete with non return valves and blanking plates, all suitable for automatic changeover operation as supplied by Pullen Pumps Ltd. Type Duopul, Holden & Brooke Starline Dual Set or Grundfos, twin head.

All of the pumps shall be provided with a pair of isolating valves and include a union or flange within the arrangement. All twin set pumps shall be provided with a blanking plate and spare gasket mounted adjacent to the pump concerned.

All wall mounted pumps shall be provided with built in wall supports to allow the pump to be positioned well forward of the wall if needed to allow other pipelines and conduits to pass.

The pipework immediately adjacent to the pumps shall be used to fix the pumps to the built in supports using pipe ring clips rubber lined to reduce vibration.

Wall mounted DHWS pumps are to be provided with a non-return valve on each discharge. The pumps shall be arranged to operate across a Senflux featherweight non-return valve suitable for horizontal mounting when positioned in the flow main. The pumps and motors shall be sized to achieve the performance stated in this Specification.

Each pump or where twin head, pump set shall be provided with flexible connections at inlet and discharge.

Each pump shall further be selected to operate at the midpoint of its range to facilitate future increase/decrease in capacity and motors shall be adequately rated to prevent over loading.

The Contractor shall supply 3 copies of the manufacturer's characteristic curves for the above pumps and shall be responsible for checking the pump duties after the preparation of working drawings and prior to the ordering of the pumps. Each pump shall be suitable for the temperature of and type of fluid within the circuit.

5.5 Fan Coil Units and Heat Emitters

a) Fan Coil Units

The Contractor shall supply, deliver, install, commission and test fan coil units in the positions shown on the drawings. The fan coil units shall be of the 4 pipe pattern unless noted as heating or cooling only when this shall denote 2 pipe pattern.

i) Horizontal and Vertical Chassis Units:

The units shall be packaged, factory assembled units suitable for mounting within the false ceiling, or within perimeter casing comprising heat exchange coils, chassis, fan deck, 'horizontal' condensate tray, fans, motors and filter. The units shall be thermally insulated with high density Class O insulation. The drain pan from each unit shall be extended out to cover the local cooling isolating and control valves for that unit.

ii) Coils:

Each coil shall comprise aluminium fins with integral drawn special tempered copper primary tubes. Return bends and header connections shall be copper alloy brazed. All coils shall have been tested to 10 bar gauge pressure.

iii) Condensate Drain Trays:

Fully insulated galvanised sheet steel drain trays shall be provided under the cooling coils, to catch condensate from the cooling coils and associated chilled water control valve and isolating/regulating valves. Each drain tray shall be provided with a condensate drain connector and the tray shall be laid to fall to the drain. All units shall be mounted to ensure that the condensation drains away. Where condensate pumps are specified these shall be piped in PVC tubing to the nearest foul drain point.

iv) Fans:

Fans shall be of the forward curved double inlet centrifugal type, manufactured from single steel with aluminium rotors, balanced for quiet operation. Each unit shall be capable of its duty against the external resistance quoted and within the parameters of the noise level specified. The complete fan deck shall be easily demountable from the unit for maintenance.

v) Motors:

Motors shall be totally enclosed, thermally protected, tapped wound, permanent split capacitor, fitted with sealed for life sintered self-aligning sleeve bearings, and resiliently mounted for quiet operation. Rating to be continuous. All motors shall be suitable for operating on 240v, 1 phase, 50 Hz electric supply.

b) Fan Convectors

The Contractor shall supply, deliver, install, commission and test fan convector heaters in accordance with the Schedule on the drawings and in the approximate positions indicated.

Each heater shall be provided with low temperature cut out, washable air filter, manual air vent and stove enamelled casing of colour to be advised.

The fan convectors shall be floor mounted on skirting height timber or metal plinths with pipework entry generally through the plinth.

Each fan convector shall be provided with a pair of 15mm or 20mm angle hand wheel and lock shield valves concealed within the casing of the fan convector.

The Mechanical Sub-Contractor shall clean the air filter of each heater on the day of issue of Certificate of Practical Completion for the building.

c) Radiators

The Contractor shall supply, deliver, install, commission and test radiators in accordance with the Schedule or the drawing. The radiators shall be positioned approximately as shown on the drawings.

Each radiator shall be mounted on the manufacturer's recommended number of supporting brackets and fixed by the Mechanical Sub-Contractor using white metal plugs and screws or expanding type metal fixings. Generally radiators shall be fitted above skirtings.

In the case of cast iron radiators all top fixings shall consist of a clamp and screw on stay. The bottom fixing shall consist of either the screw on support or the floor support depending on the detailed mounting height required. The type of bottom fixing will be settled on site when sill and skirting heights are known.

Each radiator inclusive of steel, cast iron and repositioned radiators shall be provided with 15mm or 20mm diameter top and bottom opposite end connections with thermostatic radiator valves in the flow and matching lock shield valve in the return. The TRV's shall be of the integral sensor type, straight or angled and shall be nickel plated finish. The connection positions and valve style shall be chosen to give the neatest possible installation.

The top connection position not being used shall be fitted with an ⅛th" BSP brass recessed air vent plug. The lower unused connection position shall be provided with a drain cock if the radiator is the lowest component on the sub circuit or fitted with a brass recessed plug if a drain cock is to be fitted in adjacent pipework.

All radiators shall have enamelled finish to a colour to be advised prior to ordering.

Where radiators are to be positioned under window sills the Mechanical Sub-Contractor shall check the actual site dimension from sill to floor before ordering the radiator. Should there be any doubt about the sufficiency of the sill height the matter shall be brought to the attention of the Engineer.

The Contractor shall allow for the dismantling and re-erection of radiators to allow painting or decorating of the rear of the radiators and the wall behind radiator positions.

5.6 **Air Handling Units**

a) General:

All air handling plants shall consist of the matching sectionalised plant components as described in the particular specification and shall comply with the relevant materials and workmanship specification described hereunder. All materials supplied and installed in the Works shall be new and in accordance with the latest issue of the relevant British Standard Code of Practice, and suitable for the purpose intended. The Contractor shall ensure that the design and construction of the units comply with the performance requirements of this specification.

b) Plenum Enclosures:

The assembly framework shall be manufactured in a penta-post construction from rolled electro zinc coated 1.6mm thick steel, fully welded corner joints with fishplates and intermediate stiffening members welded into place to give the complete framework maximum strength and rigidity. Within the framework shall be removable double skin infill panels properly reinforced of 1.2mm thickness galvanised sheet steel outer skin and a 0.7mm galvanised sheet steel inner skin. Within the casing infill panels mineral fibre thermal/acoustic insulation shall be bonded to the inner skin.

The insulation shall have a nominal density of 60 kg/m³ and shall be a minimum of 50mm thick.

During manufacture all cut edges shall be rich zinc primed. All internal galvanised surfaces shall be left unpainted unless stated otherwise elsewhere.

The unit shall be so constructed that individual items of equipment can be removed for inspection or replacement without disturbing the remainder of the plant. Each section shall be internally flanged and bolted to the next section, with mastic sealant being used to prevent air leakage/water penetration between sections. The construction of the enclosures and materials used shall generally be in accordance with HVAC standard ductwork

Specification DW 144 1998 for the system grade as stated in particular specification and leakage rates shall not exceed those requirements.

Thermal or sound insulation material applied shall be rot proof, odourless, non hygroscopic and not sustain vermin or bacterial growth and shall have a Class '0' fire rating. Asbestos, Polystyrene, Polyurethane, Phenolic foam or urethane type insulants will not be permitted.

Access doors/panels shall be provided where necessary and as indicated on the drawings and in particular to ensure that all internal items of plant can be removed and to enable maintenance. Access doors shall be hinged, and be provided with retaining latches and operating handles to an approved pattern. Edge seals shall be incorporated to form an air tight seal when closed. Access shall be from the side of the unit. Service penetrations for pipework, cabling and sensor/control lines shall be capped and sealed in an approved manner to ensure air tightness. Service penetrations shall be cut in and finished at the manufacturers works prior to despatch. Sections used for maintenance access shall have the floor sufficiently braced and stiffened to support the maintenance activities required therein. Floors shall generally be flush and free from

projections. All internal projections i.e. flanges, nuts, bolts, etc., shall be free of sharp dangerous edges.

c) Filters:

Filters shall be of the type stated in the particular section of this specification and in accordance with the following. Adequate provision shall be made for eliminating air by pass between each filter and banks of filters by neoprene gaskets or similar. All filters shall be mounted in a metal frame, with either front (dirty) or side removal. The frames shall be manufactured from galvanised steel and be installed with sealant between frame sections and supports to ensure that air bypass between filters and frame of the air handling unit is eliminated. Filters should be able to be replaced without any need for special tools.

All filters in both air handling units, fan units and fan coil units shall be replaced after commissioning and testing and before final completion/handover.

i) Throwaway Panel Type

Filters shall be of the throwaway panel type, capable of a minimum filtration standard of 96% when tested with BS 2381 : 1957 test dust No 2 by weight, when either clean or dirty. Operational filter resistances shall be in the order of 30 Pa clean to 120 Pa dirty. The filters shall be capable of the performance stated at the designated plant duty and shall have a maximum face velocity of 2.0 m/s.

ii) Bag Filters

Filters shall be of the bag type with multilayer construction. The filter shall be capable of an average synthetic dust arrestance of 90/95% and an average dust spot efficiency of 60% using Eurovent 4/5. Test procedures at nominal air flows either clean or dirty. Bag lengths shall be 380mm unless otherwise stated. The filters shall be capable of the performance stated at a nominal capacity of 3700 m /hr for a single 610mm W x 610mm H filter module. Operational filter resistance's shall be in the order of 200 Pa to 350 Pa.

d) Fans:

Fans should be selected for good efficiency and minimum noise, but the overriding factor should be the selection of a fan characteristic such that the air volume is not greatly affected by system pressures due to dirty filters or external wind effects.

Fans shall be of the high efficiency centrifugal type, having backward curved impeller blades of the aerofoil section securely riveted or welded to the impeller cage. Impellers shall be keyed to the driving shaft. Any parts of the fan and accessories not galvanised shall be fully protected against corrosion by the application of a works primer. Fan casings shall be fabricated from heavy gauge mild steel plate, braced with angle steel stiffeners to prevent drumming and extended to base level complete with mild steel angle base. The fans shall be provided with a large set screwed access door in the fan scroll to enable inspection and cleaning with the minimum of dismantling. The door shall be fitted with a flexible gasket to ensure complete air tightness.

The Contractor shall supply the manufacturer's certificate, stating that each fan has undergone static and dynamic balancing and shall further ensure that each

fan is running in balance to the satisfaction of the Consulting Engineer. Impeller shaft bearings shall be supported on bearer bars fixed on each side of the fan casing. Fans shall be fitted with a 12mm drain plug and be fitted with a flexible connection between fan scroll and unit casings.

Fan shafts shall be constructed from best quality machined bright steel adequately sized to ensure that maximum running speed is not more than 20% less than the first critical speed. All pulleys etc., shall be keyed to the shaft. Fans shall be belt driven; each fan and motor pulley cast in one piece, accurately machined to give perfect balance, grooved to receive the necessary number of belts and keyed to the driving shaft. Guards shall be fitted to each drive belt section where air handling units are of "walk in" pattern or where bolts and motors are externally mounted in accordance with health and safety regulations.

A mild steel frame shall be provided with each fan to carry both frame and motor, and shall be supported on adequately sized rubber in shear or spring anti vibration mountings to ensure compliance with this specification.

The Contractor shall provide means either on the fan or elsewhere within the total plant to measure the fan total volume and pressure development to within plus or minus 5%.

Starters shall be supplied and installed remotely by others. The specialist, however, shall allow for motors up to 7.5 kW to be suitable for direct on line starting. Motors 7.5 kW and above shall be suitable for star delta starting. Motors shall be rated at a minimum of 10% above maximum absorbed fan horsepower plus drive loss power.

Electrical wiring to IEE Regulations (16th Edition) shall be run from the fan motors external to the unit to terminate at an isolator(s) mounted in an approved location(s). A second isolator may also be required to be installed internally to ensure compliance with IEE Regulations 16th Edition if the external isolator has been mounted in excess of 2m from the fan motor. Motors shall be suitable for A.C. Operation from a 3 phase 415V 50 Hz electrical supply of squirrel cage induction type.

The motors shall be of British manufacture having cast iron frames as the TEFC type in accordance with BS 4999 parts 20 and 21 having a minimum weatherproof construction of IP55 BS 5499. Insulation shall be Class E to BS 2757. The motors shall be single speed. Cast iron terminal boxes shall be suitably glanded to receive cables. The complete assembly should be weatherproof to IP55. All wiring ends shall be brought out to the terminal box with links.

All fan resistances stated have been calculated based on a particular selection of equipment. The final selection of plant duties by the Contractor, such as filters, coils, attenuators, diffusers, etc., and the actual ductwork fabrication drawings may produce different pressure drops and therefore the Contractor shall re-calculate the total system resistances based upon his selection of plant and revise the fan resistance as necessary to achieve the design air volume flow. Filter air resistance's are to be taken as "dirty". Similarly, if the fan power requirements and sound power level changes, he shall re-select the necessary motor size, wiring and suitable attenuation to achieve the designed Noise Rated level stated elsewhere. Approval shall be required before any orders are finalised for the fan sections.

e) Cooling Coils:

Cooling coils shall be capable of the minimum duty given in the particular Specification at a maximum velocity of 2.4 m/s or less if required to prevent moisture carry over. Eliminator plates shall be incorporated if required to ensure that no carry over occurs at design conditions.

The coil shall comprise rolls of horizontal copper tubes, with aluminium fins with additional plastic spray coating for combat of coastal corrosive environment when called for. Tubes shall be of solid drawn copper, expanded on to flat aluminium fins.

Tube wall thicknesses shall be to suit the test pressure but not less than 0.55mm. Fins shall be not less than 0.22mm thickness and be no closer than 330 fins/metre.

Framework retaining the coil shall be manufactured from galvanised sheet steel with galvanised sheet steel around both faces, as applicable.

Condensate drain trays shall be fitted at vertical intervals as necessary to facilitate proper drainage of the fins. The drain trays shall be through the full depth of the coils, manufactured of not less than 1.2mm (18g) thick stainless steel. Each tray shall be provided with a non corrosive drain connection of not less than 22mm nominal bore copper.

Primary tubes shall be brazed into copper return bends terminating in copper flow and return headers having copper connections. Pipework connections shall be on the same side and shall have gunmetal flanges to BS Table E terminating on the outside of the unit. Return bends and headers shall be housed in pre insulated vapour sealed end boxes.

Boxes shall be galvanised and readily removable without damage to internal or external pipework insulation. Flanges and pipework connection centres shall be arranged such as to permit individual insulation of connecting pipework and flanges.

Drain connections shall be in copper complete with an air tight water seal trap equivalent to twice the fans static pressure, and fitted with a plain end for discharge to a floor gully, separated from the main drainage system by an air gap. Drain connections shall terminate outside the coil enclosures for direct connection.

The coils shall have vent and drain down facilities and shall be designed for free drainage and venting. The coils shall be rated to BS 5141 Part 2 1977 and shall be subjected to an under water test of 2100 kPa before assembly into the unit casing.

The CHW coils shall be installed in the air handling plant section complete with blanking plates to prevent air by passing the transfer surfaces.

f) Heating Coils:

Heating coils shall be capable of the minimum duty given in the particular Specification at a maximum velocity of 3.5 m/s and generally in accordance with (e) cooling coil except no drain pans.

Where heating coils are used as frost preheaters the specialist should note that the coil is sited prior to filters within the unit and account should be taken of dirt and dusting in determining fin spacing, etc. Generally, these would be plain tubing with no fins.

g) Humidifiers:

The humidifiers shall be of the steam injection pattern to Water Board approval suitable for direct connection to Mains Water Service.

Each humidifier shall be supplied complete with:

i) Local and remote indication of "Change Steam Cylinder".

ii) Facilities for step control or full modulating as detailed in the particular specification.

iii) Suitable for use with a 415 volt 3 phase 50Hz electrical supply.

iv) Automatic blow down cycle

v) Sparge pipes and cross braided hose to suite the plant size and duties required. Each hose shall be securely fixed to the sparge pipe and unit discharge.

The humidifier shall be mounted, externally, on the side of the air handling units. The air handling unit floor shall be fitted with a drain tray and drain connection down stream and beneath the spare pipes for collection and disposal of condensed steam etc.

Sufficient length shall be allowed for on the units to enable full and correct atomisation of the water vapour without carry over in accordance with the manufacturer's requirement.

The humidifier installation shall be complete with mains water connection, double check valves, isolating valves, etc. to Water Board Regulations, and 32mm insulated copper drain which shall be run to discharge into a convenient drain point.

h) Motorised Dampers:

Motorised dampers shall be installed where required to achieve the correct control and operation of the air handling plants in compliance with this specification. Dampers shall be of the opposed blade, interlocking pattern complete with operating rod.

Modulating dampers shall be suitable for the velocities and pressures applicable and selected using a characteristic to ensure that the pressure drop across the damper has 'authority' over the remainder of the system, and that fresh, return, exhaust air dampers maintain constant mix and air flow at a given output.

Actuators shall be installed within the AHU casing. The AHU manufacturer shall allow suitable space and provide fixings. Where the actuators are called for externally the AHU manufacturer shall include for extended shafts and fixing plates accordingly.

i) Vibration:

The Contractor shall include for all anti vibration measures necessary for the isolation of 99% of all vibration generated by the air-handling plants under all operating conditions.

This shall include the supply of anti-vibration hangers and 'Tico' Pads as required in addition to spring/rubber in shear anti vibration mountings for all fan assemblies. The Contractor shall state his provisions within his returned tender.

j) Leakage Tests:

The Contractor shall include for the air handling plant components to be manufactured and leakage tested once installed in their final location in accordance with the HVAC DW 144 Specification for high pressure classification sheet metal ductwork and for low and medium pressure ductwork if leakage testing is specified.

k) Noise:

The Contractor shall include for all attenuation measures necessary in the design and construction of the air handling units to ensure that the noise levels as quoted in this specification are not exceeded.

l) External Units:

All external units shall be weather proof with a pitched roof with overhang. All finishes and isolators shall be weatherproof.

m) Tolerances:

Units shall be manufactured such that the component sections once erected are aligned both top and sides within a tolerance of plus or minus 1.5mm.Where units are to be mounted on a concrete or steel base, where the floor tolerance is 15mm the Contractor shall allow for providing a channel section base capable of supporting and levelling the unit. Channel section bases may also be required as stated in the particular specification and shall be primed with two coats of zinc rich primer then undercoated and finished in 2 coats of acrylic or epoxy paint to a BS colour.

5.7 **Automatic Controls**

5.7.1 **General**

The automatic controls shall be designed, constructed and installed in accordance with the following to achieve the mode of control as described in the particular specification. The automatic controls shall be fully tested and commissioned in accordance with "Testing and Commissioning" as described herein. The control specialist's attention is drawn to the requirement to demonstrate the correct operation of all systems and for returning to site to reset the controls for the opposite season.

Unless specifically stated otherwise in subsequent sections of this Specification, the scope of the controls work shall include the construction, supply and installation of all panels, controls and power and control wiring emanating from the panel(s). Power

supplies from electrical distribution boards to the incoming terminals or panels is normally undertaken by another Contractor.

5.7.2 **Control Panels**

Panels and controllers shall comply with BS587, and enclosures shall be dust and damp protecting. Ventilating fans and louvered vents shall be installed to avoid overheating.

Each control panel shall be suitable for wall or floor mounting to suit the application above. Sharp edges or corners will not be accepted and all exposed screws, bolts and other fixings shall have rounded heads with protective and decorative plating. Panels shall be stiffened as necessary to ensure rigidity.

The panel shall be arranged for front access with hinged doors and with removable plates for cable entry.

Panels shall be of folded type construction using best quality mild steel plate not less that 2mm thick for all floor-standing and wall mounting panels larger than 900mm square, but for smaller panels lighter gauge may be used.

Floor standing panels shall be fitted with certified lifting eyes complying with BS 4278 for this application. The panel shall be suitably strengthened by welded angle iron to spread the load.

After prefabrication, all panel sections shall be degreased, etched and primed before stove enamelling to approved colour (BS number to be advised).

Door construction shall be in the form of rigid tray with dust protective joints at all edges. Hinges shall be of the type which will allow the removal of the doors if required.

Doors providing access to live equipment shall be inter-locked with the isolators, all remaining doors shall be provided with locking type door handles using one common key for all locks on given panels. One key shall fit all locks provided on all panels.

Where recessed wall mounted panels are specified these shall be suitable for recessed fixing and be complete with bezelled edge flange. The colour shall be to an approved British Standard colour.

The panels shall be fully wired internally to terminal strips at the Manufacturer's works ready for receiving incoming and outgoing cables All internally mounted cables shall be neatly clipped and adequately supported in PVC trunking. Wiring shall be identified with a numbered ferrule at each end and at junctions.

The panels shall be provided with one set of 'Klippon' terminal boards, to receive all incoming and outgoing circuits, and transformer operated lamps to indicate panel is alive, i.e. 'on' and 'fuse' failed. All indicator lamps shall be transformer operated 240/6 volts.

All wiring shall be in accordance with the IEE Regulations 16th Edition with latest amendments.

The panels shall have automatic controls, relays, starters, processors, etc., mounted inside the panel.

Each panel shall be provided with a main incoming rotary isolator capable of carrying the full load current of the three phases four wire and one phase supply for all starters etc. as applicable. Each panel shall be complete with multi TP and N distribution board with MCB's for all starters, control circuits etc.

All rotary switches, 'run' and 'tripped' lights, push buttons, engraved identification labels etc., shall be mounted on the front of the panel. A test button shall be provided to allow momentary illumination of all indicator lamps on the control panel.

Starters shall normally be rated for 'intermittent' or 'frequent' duty, but where due to the form of thermostatic or automatic control, the number of starts is likely to exceed 15 per hour, starters for 'frequent' duty shall be provided.

For starters incorporating reduced voltage starting changeover of voltage shall be automatic.

Starters shall be provided on each phase with combined thermal overload devices and single phasing protection, with adjustable time-lag and an under-voltage release. They shall be arranged to provide automatic restart on restoration of mains voltage.

Contactor operating coils shall be wound for not more than 250 volts. Where a contactor is arranged for remote operation the coil circuit shall be protected by a fuse. Terminals shall be accessible and have adequate clearance between phases and to earth.

Two spare sets of auxiliary contacts shall be provided on each starter for remote starting and stopping from an energy saving unit.

All starters shall be suitable for operating off the three phase supply other than those required for single phase. The starters shall also be arranged to operate in conjunction with the automatic controls specified herein.

Where duty and standby pumps are provided these are to be wired so that on failure of the duty pump, the standby pump starts up automatically.

Suitable indicators of pump failure shall be provided.

Each motor control/indicator panel shall have MCB's together with multi way integrators to give audible and visual alarm on any starter trip.

The alarm bell/klaxons shall be mounted inside the panels and all alarm circuits shall be arranged to operate this bell/klaxon as described later. A mute button shall be provided on the panel to allow the bell/klaxon to be stopped but the tripped light shall remain on until the fault has been cleared. The alarm circuit shall have additional controls for a remote alarm bell/buzzer, mute of fault-light.

The Contractor shall issue a schedule of labels to be screwed to the outside of the panel indicating the function of all switches, lamps, controllers etc. to the Engineer for approval prior to completion of the panel.

All labels shall be of the sandwiched traffolyte type of white/black/white colours engraved to indicate the central colour. All labels shall be screwed in position. Adhesive mounted labels will not be accepted.

The whole of the wiring shall be carried out in accordance with the latest IEE Regulations for Electrical Equipment in Buildings. All panels shall be capable of withstanding fault currents as required in the IEE Regulations.

The position of all switches, indicator lights, etc. on the front of the panel shall be agreed with the Engineer before commencement of manufacture.

Automatic starting is to be so arranged that starters will operate in sequence via time delay units to reduce the starting load on the panel.

Wiring within panels shall be carried out in colour coded high grade single PVC insulated cables rated to Manufacturer's recommendations. Wiring shall normally be colour-coded as follows:

a) Phase connections - red - yellow - blue.

b) Neutral - black.

c) Earth - green/yellow or bare copper conductor.

d) A/C voltages 100/100v live and return connections shall be brown.

e) D/C voltages wiring shall be grey.

Control circuit wiring - minimum cable size to be 1.2mm.

For cable runs, plastic trunking shall be used, but cables shall not occupy more than 70% of the volume of trunking to ensure adequate cooling.

Wherever possible, groups of any low voltage cables shall be run separately or in divided trunking.

When cables must be run in looms they shall be retained by cleats designed to prevent damage to the cable insulation. To avoid cable heating, looms shall be restricted to a maximum of 35 cables.

All cables shall be identified at each end by means of white ferrules with black lettering, these markers shall be cross-referenced in detail on wiring diagrams.

All sections of each control panel shall be effectively earthed by means of a copper conductor terminating at a suitable earthing terminal. The size of the earthing conductors shall be related to the size of the fuse protecting the main control panel, as laid down in I.E.E. Regulations. The earthing conductors shall be positioned where they can be seen and their connections inspected for good continuity. Care shall be taken to ensure low resistance connections between metalwork and earthing strips.

All doors shall be earthed with flexible braiding connecting purpose welded studs or bolts. This shall also apply to mounting plates, gland plates and other removable parts. The removal of any part shall not invalidate the continuity of the remaining system.

Where screened and insulated cables enter panels, separate insulated terminals shall be provided for the connection of the screening which shall only be earthed where indicated on the drawings.

Individual terminals shall be provided for each connection entering or leaving panels. The terminals shall be sized with regard to size and type of incoming cables and shall be located in positions to give adequate access for site wiring.

Terminals shall be numbered with permanent materials, the numbers being those shown on wiring diagrams.

Control circuit wiring connections will be made via crimp connectors with extended insulation intended for double crimping.

Removable gland plates shall be provided for cables and pipework where agreed. These shall be split as necessary to allow for cables and capillaries to enter the panel. Where extensive wiring to terminals within panels must be carried out on site, provision shall be made in the form of cable trays or trunking to enable the wiring to be neatly located.

Signal lamp colours shall normally be to BS 4099 Part 1 1976.

a) Red - Danger or alarm.

b) Yellow - Caution.

c) Green - Safety.

d) Blue - Meaning according to need.

e) White - No specific meaning assigned.

Lamps shall be selected to ensure that bulbs can be replaced from the front. All drawings shall be submitted for approval before manufacture and are to be in accordance with the appropriate sections of BS 3939.

The drawings shall comprise fully detailed schematic wiring diagrams giving cable and fuse sizes, cable terminal numbers and other relevant information; also a detailed general arrangement drawing of all equipment giving interior and exterior layout. Details of all equipment, names of manufacturers, duty ratings, etc., shall be supplied. Detailed sketches for 'Traffolyte' labels shall be submitted for approval before engraving.

All panels shall be fully tested in the form of a complete functional test which shall be witnessed by the Engineer or Facilities Engineer. The panel shall also be subjected to a high voltage flash test to ensure the level of insulation.

5.7.3 **Control Valves**

Valve bodies up to 50mm shall be screwed BSPT and above this size they shall be flanged. The body construction and flanges shall be suitable for the medium, temperature and pressure of the systems detailed below and, where not specified, flange tables must be detailed in the Tender.

Unless otherwise specified two, four and three-port modulating valves with the exception of butterfly valves shall be of the single seated plug or rotating shoe types. No plugs, shoes or trims shall be constructed of materials liable to corrode or cause sticking. On liquid applications let-by in the closed position shall not exceed 0.5% of full duty for plug type valves or 1% for shoe types.

The valve bodies shall have equal percentage or modified parabolic characteristics arranged so as to give a constant total flow characteristic and linear output of the heater/cooler battery which it is controlling, together with a rangeability not less than 40:1.

Only the bottom port on three-port valves shall be used for by-pass connections.

Two position valve bodies shall confirm with the requirements of the above modulating valves with the exception of characteristics and rangeability.

All valves shall be fitted with valve plug position indicators. All valve control apertures on full flow shall be sufficient to not require local strainers to be fitted at each control valve.

All valves shall be tested to a pressure of at least 200% of their standard rated working pressure. Any special valve bodies shall be to the individual data detailed elsewhere.

Where pressure drops are stated in the specification or schedule they are for the equipment being controlled at the designed flow rate. The control valve shall be selected at a minimum pressure drop of 70% and maximum pressure drop of 150% of the battery being controlled at the design flow rate and shall state the exact pressure drop for each valve in his returned Tender.

All heating control valves shall fail to the open position; all cooling control valves shall fail to the closed position.

5.7.4 **Pipework Immersion Thermostats and Detectors:**

All detectors, thermostats and liquid sensors shall be fully immersed and provided with ½" BSP pockets. Pipeline changes of directions or enlargements shall be provided as necessary.

All thermostats or detectors shall be suitable for the temperature and pressure of the system in which it is to be installed. The length of the thermostat shall be sufficient to provide a good average representative reading of the temperature of the system at the point of measurement.

Sensitivity shall be such that changes of 0.3°C from the stabilised insulation at the detector are sufficient to commence modulating the corrective element. Adjustment of the desired value shall be from the associated control panel.

Ranges and proportional band adjustment shall be suitable for the application and subject to approval.

Where immersion thermostats are fitted externally to the building, they shall be of the fully weatherproof pattern.

5.7.5 **Ductwork and Air Handling Unit Mounted Detectors**

Ductwork thermostats or detectors shall be mounted with sealing glands and flanges for easy removal. All detectors shall be accessible and be identified by labelling.

Detectors shall be supplied and fitted into the respective duct/plant by the Controls Specialist. Each detector shall be suitable for the temperature of the system in which it

is installed and the length of the thermostat shall be sufficient to provide a good representative average reading of the air temperature at that point, allowing for any stratification, etc.

Sensitivities shall be such that changes of 0.2°C or 1% RH from the stabilising condition at the detector are sufficient to start modulating the corrective element. Adjustment of the desired value shall be from the associated control panel (except where providing room control).

Humidity detecting elements shall not require regeneration.

Ranges and proportional band adjustment shall be suitable for the application and subject to approval.

5.7.6 **Room Thermostats/Detectors**

Each room detector/thermostat shall be mounted in an approved position and shall be supplied complete with suitable connections for pneumatic pipework or conduit as applicable.

Scales shall span the range of 15°C to 30°C and proportional band settings shall span the minimum ranges 1°C to 3°C. Sensitivity shall be such that the correcting element starts to operate for a change in the detector of 0.3°C.

Room thermostats shall be positioned and arranged so that there is less than 3°C difference between the temperature at the thermostat and the temperature in the centre of the room at 1m above the floor.

Room thermostats shall be of the fully tamperproof pattern, re-settable only from within and a sample shall be provided before installation. All room thermostats/humidistats shall be of matching appearance and size.

All room thermostats shall be clearly labelled and easy to use by untrained Main building staff.

5.7.7 **Motorised Control Dampers**

All dampers shall be provided with extended spindles for motorised attenuators.

The dampers shall be mounted to the AHU complete with any necessary linkage devices and fixed in positions which do not obstruct access panels.

5.7.8 **Field Control Wiring:**

All control wiring to the complete control system shall be in accordance with IEE Regulations 16th Edition and current amendments.

Wiring shall be carried out in PVC insulated cables enclosed in heavy duty galvanised conduit and cable trunking, completely separate from other systems, used solely for control cabling.

External cabling shall be as above but in weatherproof/galvanised conduit and/or trunking, or using PVC insulated steel wired armoured PVC sheathed cables.

Wiring shall be screened where recommended by the manufacturers of the associated equipment.

5.7.9 **Mechanical Services Power Wiring**

The controls specialist as identified in the Particular Specification shall wire all items of mechanical plant derived from the mechanical control panel, including for all cables, supports, trays, trunking, conduit, isolator, testing, etc., as appropriate. The whole of the installation shall be in accordance with 16th Edition IEE Wiring Regulations 1992 and all current amendments.

The wiring shall be in accordance with the Electrical Materials and Workmanship Specification (3.M.E) and in accordance with the Particular Specification.

5.7.10 **Pneumatic Pipework**

Copper pneumatic pipework shall be used in all areas that are exposed to view. Plastic pipework may be used within the false ceilings. All pipework to be run on galvanised cable tray or within galvanised conduit.

All pipework shall be in accordance with the following:

All copper pipework shall be installed neatly clipped and bracketed, and fixed at intervals not exceeding:

0.45mm	for 8mm o.d. tube
0.60mm	for 12mm o.d. tube
1.0 mm	for 15mm o.d. tube
1.25mm	for 28mm o.d. tube
1.80mm	for 42mm o.d. tube
2.50mm	above 42mm o.d. tube

Plastic pipework, where permitted, shall be clipped or bracketed at intervals not exceeding half those quoted for various sizes of copper pipework.

All detecting devices and control motors shall have their terminations made off in flexible form to permit removal of the devices without disconnection and to avoid unnecessary vibration.

Capillary fittings shall, when completed, be neat and smoothly finished without tears.

All air pipework shall be routed to fall in the direction of air flow, to ensure adequate drainage of moisture. All low points, such as the bottom of vertical risers, along main runs where trapping is required and at the ends of main runs, shall be fitted with automatic drains as part of the installation.

Open ends of pipework shall at all times, except prior to connecting up and during testing, be kept sealed to prevent the ingress of foreign matter. Each section of pipework shall be tested after installation as described elsewhere.

An allowance of 9m of pipework shall be included from each automatic drainage point to drain including the final connection to drains.

Copper pipework shall conform to the composition requirements of BS EN 1057 1996. Copper of 15mm o.d. and below 15mm o.d shall be half hard. Capillary fittings shall be

as manufactured by Yorkshire Imperial Metals Ltd. Compression fittings shall be those normally supplied with the items of control equipment but if other fittings are required they shall be as supplied by Simplifix Ltd.

Plastic pipework shall be in flexible polyethylene,100 density, black tube with self-extinguishing fire properties, suitable for the air pressures involved.

5.7.11 **Pneumatic controls**

Master instruments shall each be supplied with a pressure gauge, minimum diameter 40mm, indicating the output pressure. Sub-master instruments shall be provided with a further gauge of the same type indicating the reset pressure.

Pneumatic actuators shall have diaphragms of a synthetic or impregnated rubber not subject to ageing or hardening due to flexure, within the temperature range - 15°C to 100°C.

The diaphragm shall offer a constant area to be applied pressure throughout its stroke.

Actuators shall provide a linear variation in movement of the stem from one extreme to the other over the range of input pressures detailed or implied elsewhere. Sufficient thrust shall be developed to overcome the maximum out of balance pressures across the valves and dampers with which they are associated.

Each actuator shall be supplied complete with all necessary fittings and connections for mounting on the associated valve body.

Positive positioners for valve and damper actuators shall incorporate mechanical feed back of stem position. They shall be capable of 1.8 bar and their output shall be variable between 1.2 - 2.0 bar.

Supply air pressures up to 2.7 bar shall not alter the output characteristics of the positioners. Positioners shall always be provided on modulating damper actuators and on all actuators in two stage sequence control.

5.7.12 **EMS and BMS Systems:**

General

Where either a software driven Energy Management (EMS) or Building Management System (BMS) is required this will be specified in subsequent sections of this document however the hardware, control enclosures, actuators, detectors, etc., of such systems shall, where relevant, comply with the general standards of materials and workmanship stated in Clause 3.M.9.

The Contractor shall employ the BMS controls specialist named in subsequent sections to design, supply, install, set to work, commission and demonstrate the whole of the BMS system.

The BMS specialist is to include the following works:

- The complete design, supply, configuration, documentation and commissioning of the BMS system.
- Manufacture and commissioning of the motor control panels.

- Enclosure of BMS outstations in panels to comply with this specification either integral with motor control or in separate panels.
- All control wiring.

Note:

Power wiring will, unless stated otherwise, be carried out by the Electrical Contractor.

Installation

The BMS shall be installed complying with all:

- National and local statutory regulations.
- Health and Safety at Work Acts.
- IEE Regulations (16th Edition).
- Equipment manufacturers instructions.
- Regulations and conditions of BT, and utilities companies.

All BMS/EMS outstations will be independently memory resident to allow control in the event of disruption to the interconnecting communications

All extra low voltage BMS cables shall be run in screened twisted pair cables. They shall be affixed to tray, drawn into conduit or trunking and protected as agreed with the engineer to suit the various locations. All cables to be in galvanised metal trunking/conduit in plantrooms and service voids. No joints will be allowed in cables, where these are unavoidable, the cables shall be joined using an approved housing, securely fixed and having cable security clamps. Any such connecting boxes shall be shown on the record drawings. Where cables are connected to sensors measuring extreme heat, the necessary thermal breaks, local connecting cables are to be supplied. No BMS data cable shall be installed in the same conduit as any power cable nor affixed within 25mm if surface/tray mounted. Where cables are run in trunking or with others clipped to tray of a similar type they shall be identified either by colour or labels every 2m.

Special care shall be taken to ensure that the manufacturer's recommendations with respect to earthing data cables and outstations are obeyed.

Each BMS field device shall be identified with a common code used on points and wiring schedules, parts lists, control strategy, MCP and installation diagrams/drawings.

All BMS cables shall be suitably identified with sleeves at the terminations. These shall be recorded on the installation diagrams and wiring schedules.

Sensors, actuators, switches and all field devices shall be mounted according to the manufacturer's instructions. All will be installed with clearance to allow for servicing, and the conduit connected by methods to allow easy replacement.

Where outstations switch circuits having potentially different mains voltage supply feeds, extra low voltage relay circuits shall be employed. A notice shall be fixed inside the outstation detailing how all mains feed into it can be isolated. Consideration shall be given to employing an extra low voltage control circuit for motor starter and contactor coils and shall be mandatory where MCP with separate cubicles for motor starters are employed.

Network cables will be supplied with at least two spare pairs to allow for future system expansion.

Each outstation shall be provided with a schedule identifying the points connected to the terminals inside the panel door.

During the installation period the BMS specialist shall provide dust protection for his PC equipment to minimalize damage from dust anticipated during the works.

Wiring within the outstations shall be completed in a neat and professional manner with lacing/cable ties. No wired connector shall be in tension by wires cut too short, earthing braids/wires shall be neatly terminated. Prior to commissioning each outstation enclosure shall be cleaned of all cable waste.

Commissioning

a) The BMS specialist shall be responsible for the full commissioning of his system and any other controls equipment supplied by him.

b) All safety interlocks, overrides and fail safe conditions are to be operational prior to starting the plant and demonstrated as agreed with the engineer prior to starting plant in BMS auto mode.

c) Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective as soon practical once BMS control mode is selected.

d) Sensors shall be checked to ascertain accuracy within limits, pressure switches checked for switch points and hysteresis. Humidity sensors shall be checked for accuracy using a wet/dry bulb thermometer.

e) All the necessary test equipment and materials used in commissioning shall be supplied by the BMS specialist. All test equipment shall have valid test certificates.

f) Trend graphs will be provided to demonstrate the stable control of the plant. Simulated inputs will be employed to check stability over the design environmental range.

g) The BMS specialist shall allow two additional full days by his commissioning engineer re-visit the system at a later date (after handover.) He shall check and adjust operational parameters, and re-tune any control as may be required by change in the control system load conditions or bedding in of the plant.

h) The BMS Contractor shall include in his tender an allowance for system tuning via auto dial or visit to check correct operation of all plants which may exhibit changes instability or seasonal conditions.

i) Commissioning documentation and schedules shall be submitted for approval during the design phase showing each plant, point, interlock and control algorithms, and the stages of checks and commissioning required. Each cleared item to have date and engineer reference. Completed copies shall be available to the engineer prior to acceptance testing. A complete set of the commissioning documentation is to form part of the system documentation.

j) Once any item of plant is commissioned and left running to the dictates of the BMS documentation showing the overrides, control and software configuration shall be available on site at all times. All system documentation shall be in accordance with the BMS manufacturer's standard templates.

5.7.13 **Demonstrations to the Engineer and Handover**

The BMS specialist shall given seven days' notice to the Engineer of his intention to provide the acceptance demonstrations once the commissioning is complete. The operation of all systems shall be tested and points shall be selected by the Engineer and demonstrated for operation/accuracy. The BMS specialist shall supply sufficient main power/test equipment, consumable items and portable telephones to conduct the demonstration efficiently. Testing shall also incorporate an audit of wiring and hardware installation, demonstration of safety interlocks, start of system from power down and review of time schedules and alarm levels, grouping and selected control parameters.

The BMS specialist shall ensure the following are completed at handover:

- Any snagging to be documented and agreed date determined for clearance.
- All passwords/pin numbers, levels and operators recorded.
- Disk copies of all systems and data files supplied.
- Proprietary software manuals and disks.
- Consumables, printer ribbons, printer paper at agreed levels.
- All equipment access keys handed over.
- Complete sets of O&M Manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.
- Training of Engineers and operators to be checked complete or program for completion agreed.

5.7.14 **Documentation**

Final O&M Manuals will be supplied within the mechanical services manual as specified in Clause 2.30.

Operating manuals shall comprise instructions on equipment safety checks, start up and close down procedures, daily operation and full descriptions of operating features. These shall match and comply fully with the software supplied, provide examples of operation with supporting flow/strategy diagrams. Diagrams shall show the full diagrammatic (network structures, outstations and peripherals) and physical layout of the system and components.

Maintenance manuals shall comprise full descriptive and maintenance details on each and every item of equipment supplied. Suppliers and spare parts references, contacts, telephone numbers, and addresses shall be supplied where relevant. Wiring schedules shall show the connection of each item of equipment to the field equipment. Data sheets and maintenance configuration of all control and monitoring schemes, identifying the modules used, their interconnections and setting parameters, copy printouts showing the individual outstation module configurations and sequences.

Record drawings of the installation will be supplied on Auto Cad disk and hard copy as per Clause 2.29.

Back up copies of all system configuration files and master software disks shall be supplied in an appropriate lockable storage facility. All system and data files shall be current as at the handover date, disks to be suitably identified and directories and files cross referenced in the maintenance manuals. The storage unit and key shall be handed to the Engineer at handover.

5.7.15 **Site/User Training**

The BMS specialist shall supply the following training for the Client staff:

- Off site prior to handover at manufacturer's works; non-specific system structure, components and applications. Operation of user terminals, keyboards, use of displays, overrides and passwords.
- On site; specific system structure, outstation locations, control strategy overviews. Operation of user terminals, adjustments, trend graphs and alarm handling. Other networked components.

5.7.16 **Warranty, Support Period and Maintenance Contract**

The warranty period shall run for 12 months following handover, during which time the following facilities shall be available to the Client:

- Call out during normal working hours within 24 hours and same day if before 10am.
- Replacement and labour for defective parts.
- Fault diagnosis and rectification.

The whole of the new installations shall be tested and commissioned in accordance with Clause 3.M.10 and to the satisfaction of the Engineer. The whole shall then be demonstrated to the Client.

5.8 **Testing and Commissioning**

a) General

The Contractor shall include for commissioning and testing all services by the respective manufacturer/supplier and the Contractor shall allow for the services of these manufacturers/suppliers on site. The Contractor shall also include for the services of a reputable commissioning company to commission and test the installations. Proposals for the commissioning company shall be submitted with the returned tender.

Testing of installations may be required in sections to suit the programme of work and to allow other sections of the work such as insulation to proceed in shortest overall time sequence.

Commissioning shall be in accordance with the Chartered Institute of Building Services commissioning codes:

Code A for Air Distribution Systems
Code C for Controls Systems
Code R for Refrigerating Systems
Code W for Water Distributing Systems

and to the relevant British Standards and Codes of Practice and Building Regulations.
In addition, the air distribution systems shall be commissioned using the application experience by BSRIA Application Guide 1/75.

A commissioning plan shall be provided by the contractor showing that all systems are covered and in logical order.

Commissioning sheets for water services shall be completed as per Hattersley Newman Hender standard sheet for Water Distribution for commissioning valves and all settings shall be recorded.

The Contractor shall include for providing and holding on site until the last plant is handed over, all instruments required to test and commission the mechanical services installation in accordance with the above.

The commissioning shall also include the following:

i) Flush and reverse flush all pipework systems and fill with treated water as required in full accordance with Series W.

ii) Checking that all balancing and isolating valves etc., are clear of obstruction and pumps running in the direction intended. Pumps are not to be run until pipework is passed as clean.

iii) Checking that all ductwork systems have been thoroughly cleaned and are free from debris and fire dampers open. The fan systems are not to be run until this has been established.

iv) Checking that all water available for filling the pipework systems is to the required specification.

v) Witnessing the commissioning of all specialist plant items, commissioned by the specialist supplier.

vi) Checking that inter running of control panel has been completed as designed and that interlinks with the control systems have been completed.

vii) Ensuring that all control systems are functioning as designed.

viii) Taking head/volume readings on circulating pumps as a check that the pumps are operating on their proven curves and recording same.

ix) Regulate and balance all systems and log water and airflow rates and pressure readings at all regulating dampers and valves.

x) Proportionally balance all new and existing air and water systems.

xi) Pressure testing of medium and high pressure ductwork.

Records of all tests carried out shall be submitted to the Engineers. The testing/commissioning shall be carried out in a pre-arranged logical sequence from which the commissioning engineer shall not deviate without obtaining the approval of the Engineers. Any fault discovered during such tests shall be at once remedied by the Contractor at his own expense and the test re applied until the Engineer is satisfied that the section under test is sound.

All tests shall be witnessed by the Engineer or their representative and the Contractor shall provide adequate prior notice of such tests.

The Contractor shall provide test certificates to the Engineer immediately after testing, giving details of the test carried out, duration of test and the service upon which the test was carried out.

The Contractor shall provide prior to testing full details of all design volumes, temperatures, fan and pump curves, pressure drops, through plants and systems in the form of two copies of ring binders to the Engineer.

Allowance shall be made in the contract for the Mechanical Contractor to change pulley sizes and belts if necessary on all belt driven equipment inclusive of AHU fans, extract fans, pumps, etc.

b) Testing of Pipework:

All heating, steam, condensate, chilled water, water services, gas, compressed air, oil and refrigeration pipework shall be pressure tested to 1.5 times working pressure or 2 bar (g) whichever is the greater for a period not less than 2 hours. In the case of water services pipework the test pressure shall be increased to 2 times working pressure where required by the Local Water Authority.

c) Testing of Ductwork:

Ductwork systems shall be pressure tested in accordance with Appendix A of DW 142, prior to the application of thermal or acoustic insulation for all high pressure ductwork and if specified for low or medium pressure. The following shall be submitted with each test record upon satisfactory completion of the tests.

1. Description and location of section under test.

2. Length of ductwork section under test and surface area of ductwork.

3. Period of test (minutes) pressure held during test.

4. Pressure drop measured across orifice plate or other measuring device.

5. Leakage rate (litre/sec) allowable and obtained under test.

6. Leakage rate (percentage).

7. Calibration data for measuring device.

Should the test indicate a leakage rate in excess of that permitted in DW 144, the section of ductwork shall be dismantled, cleaned, and re-assembled and re-tested. Should the tests identify substantial leaks, even though the overall leakage test is within the test limits, the faulty joints shall be repaired and the test repeated. To assist in locating faulty joints, smoke or bubble testing may be used.

d) Seasonal Test:

The Contractor shall further allow for returning to site for testing/resetting for the opposite season to that which the project was originally commissioned within. This shall include the re-setting of all thermostats.

e) Disconnection:

Any items of equipment not suitable for the hydraulic test pressure for the general service for which it is normally connected, shall be temporarily disconnected to allow the main service test to proceed to full pressure. Disconnected items of plant shall then be separately tested at the lower pressure.

f) Mains Water Services:

The mains water service shall be commissioned in accordance with Water Authority's requirements inclusive of a thorough cleansing, flushing and reverse flushing, followed by chlorination then after the required standing period a further flush through.

g) Manufacturers Equipment:

All boilers, chillers, controls, etc., are to be commissioned by the manufacturer to ensure that warranties are not invalidated.

h) Proving Tests:

The Engineers will require to witness the operation/proving of all controls/systems prior to handover. The Contractors shall include for a single commissioning engineer to complete and demonstrate the systems, overseeing control specialists etc., as necessary.

i) Pressure Valves:

All pressure vessels shall be tested at works and a test certificate provided by the manufacturer to the Contractor no later than the date of practical completion.

j) Change of Filters at Handover

After full and satisfactory completion of all testing and commissioning procedures the filter media of all air handling units, fan units with filters and fan coil units shall be replaced. The replacement shall take place on the day or just prior to the day of practical completion of the installation or part installation as the case may require.

Similarly all cleanable or washable air filters shall be serviced at the time of handover.

The costs of replacement media, labour to install same and labour for other cleaning/washing shall be included in the Mechanical Contractor's contract.

k) Air Tightness Testing

The particular section of this specification may require air tightness testing of the building envelope in accordance with Building Regulations approved document L2 section 2.2 to 2.4. Where this is required the contractor shall employ a specialist company for the work who will provide a qualified person to issue a certificate of compliance. The test shall be carried out in accordance with CIBSE TM 23.

5.9 **Plumbing and Drainage**

a) Standards and Statutory Requirements:

British Standards referred to shall be the latest edition, including all amendments. All materials to be inspected upon delivery and again immediately before fixing. Damaged and defective articles shall be rejected. Damaged surface coatings shall be repaired or recoated in accordance with the manufacturer's instructions. Articles with special coatings shall be returned to the manufacturer for re-coating.

All materials shall be protected from the weather while in store and awaiting fixing. Storage of elastomeric jointing rings, fittings, instruments and any packaged goods shall be in their delivery bags or protective containers.

Pipes shall be stacked on a level surface evenly supported along their length. Do not rest pipes on their sockets. Securely stake end pipes in bottom row to prevent the stack collapsing. Comply with manufacturer's instructions including height of stack. Store materials, plant and equipment clear of the ground.

b) Cast iron soil and rainwater pipes:

Cast iron plain ended pipes up to and including 150mm nominal bore shall comply with BS 416 for above ground and BS437 for underground. Pipes shall be coated with a bitumen/asphalt compound.

Joint type: Mechanical coupling. Cast iron fittings for plain ended pipes to comply with BS 416, for plumbing and BS 437 for drainage as 'St Goblin Pipelines' or equivalent.

Mechanical couplings for plain ended cast iron pipes shall comprise a two piece cast iron collar having an overall length of not less than 75mm, a full length ribbed nitrile rubber gasket having a central pipe register, four stainless steel hexagonal headed bolts and nuts. The whole coupling shall conform to the requirements of BS 416, BS 437 and BS 6087, all as St Goblin Pipelines 'TIMESAVER' or equivalent.

c) Cast iron soil and rainwater pipes:

Cast iron plain ended pipes up to and including 300mm nominal bore shall comply with ISO 6594 for above and below ground. Above ground pipes shall be finished with two coats of antioxidant red alkyde paint externally and a black epoxy tar lining internally. Below ground pipes shall consist of a grey zinc-rich paint finished with two coats of antioxidant grey alkyde paint externally and a black epoxy tar lining internally.

Joint type : Mechanical coupling. Cast iron fittings for plain ended pipes to comply with ISO 6594 as 'St Gobain Pipelines' or equivalent.

Mechanical couplings for plain ended cast iron pipes shall comprise a two piece ductile iron collar having an overall length of not less than 58mm, a full length ribbed nitrile rubber gasket having a central pipe register, two stainless steel hexagonal headed bolts and nuts (four for pipes of 150mm diameter and over) complete with built-in electrical continuity. The whole coupling shall conform to the requirements of ISO 6594 and BS 6087, all as St Gobain Pipelines 'ENSIGN' and 'ENSIGN DRAIN' or equivalent.

d) Copper pipes:

Half Hard Copper Pipes for use above ground to comply with BS EN 1057 1996 R250. Manufactured by a BSI Kitemark Licensee.

Half Hard Copper Pipes for use below ground to comply with BS EN 1057 1996 R250. Manufactured by a BSI Kitemark Licensee.

Annealed Copper Pipes to comply with BS EN 1059 1996 R220 annealed. Manufactured by a BSI Kitemark Licensee.

Hard Drawn Copper Pipes to comply with BS EN 1059 1996 R290. Manufactured by a BSI Kitemark Licensee.

Compression Fittings for Table Y copper pipes to comply with BS 864: Part 2, Type A, manipulative type, manufactured in non dezincifiable copper alloy. Manufactured by a BSI Kitemark Licensee.

Compression Fittings for Tables X and Z copper to comply with BS 864 : Part 2, Type B (symbol 864.1)manufactured in non dezincifiable copper alloy. Manufactured by a BSI Kitemark Licensee.

Capillary solder fittings for copper pipes shall comply with BS 864 : Part 2, manufactured in copper or non dezincifiable copper alloy by BSI Kitemark Licensee. Fittings to incorporate an integral ring of solder.

Brazing fittings for copper pipes shall be manufactured in non dezincifiable copper alloy, as Delta Capillary Company or equivalent.

Copper Alloy Slip-on Flanges for brazing to copper pipes shall comply with BS 4504 : Part 2, Table 25/22, of non-dezincifiable copper alloy.

e) Aluminium Rainwater Goods

External rainwater pipes, fittings and accessories shall be in aluminium to BS2997 heavy grade 2.0mm thick as manufactured by Alumasc Ltd. Pipework to be to the profile and sizes as specified. Material to be extruded aluminium to BS1474 with factory applied electrostatic polyester coating to BS6496 to the colour as specified. Pipework shall be secured with eared sockets at 2.0m centres.

f) Plastics non pressure application:

Unplasticised polyvinyl chloride (UPVC) pipes and accessories for sanitary plumbing application shall comply with BS4514. Manufactured by a BSI Kitemark Licensee. UPVC Elastomeric ring seal fittings for sanitary plumbing application shall comply with BS4514. Manufactured by a BSI Kitemark Licensee.

UPVC Solvent weld fittings with additional approved ring seal joint expansion and contraction connections, as required, shall comply with BS4514. Manufactured by a BSI Kitemark Licensee.

Modified unplasticised polyvinyl chloride (MPVC) pipes and accessories for sanitary plumbing application shall comply with BS5255. Manufactured by a BSI Kitemark Licensee. MPVC Solvent weld fittings with additional approved ring seal

joint expansion and contraction connectors, as required, shall comply with BS5255. Manufactured by a BSI Kitemark Licensee.

Polypropylene pipes, fittings and accessories for sanitary plumbing application shall comply with BS5255. Manufactured by a BSI Kitemark Licensee.
Joint Type: Pipe manufacturers elastomeric ring seal joint.

g) Jointing materials:

Elastomeric jointing rings to comply with BS2492. Type of ring to be recommended by the manufacturer of the pipe being joined. Materials Rings for uPVC pipes and fittings to BS4514 and for MuPVC pipes and fittings to BS5255 shall be of ribbed or finned section having two or more points of contact with the pipe.

Pipe thread tape for jointing screwed joints shall be of polytetra-fluorethylene (PTFE) to BS4375, by an approved manufacturer.

Couplings and adapters to be of types recommended by the manufacturer of the pipes being joined.

Solvent cement for jointing UPVC and MPVC pipe systems. Use only solvent cement provided by the pipe system manufacturer for the type and size of pipes to be jointed.

Pipe jointing compound to be non-toxic and non-tainting. Compound must conform to the Water Authority's requirements and be approved by that Authority.

Lubricating compound for elastomeric sealing ring type joints to have bactericidal properties and be approved by the Water Authority. To be supplied by the joint fitting manufacturer.

h) Accessories:

Cover plates for pipe wall penetrations to be of hinged or snap-on-type, or rolled steel chromium plated or plastics.

Protective bandage wrapping tape to be self-adhesive grease impregnated tape as Winn Coales 'DENSO TAPE' or equivalent.

Plastic WC pan connections shall comply with BS5627. Use the following type as appropriate:

Application	Type
'S' or turned 'P' trap	'Figure 1'
'P' traps, new installations	'Figure 2'
'P' traps, replacements	'Figure 3'

i) Setting out:

The Contractor shall be responsible for the setting out of all work associated with this Contract and shall be responsible for ascertaining that the works are installed correctly in relation to datum levels, the building and to any special features or

fittings attached to it and shall take all reasonable precautions to ensure that a neat appearance is achieved. Any errors arising during the progress of the works shall be rectified by the Contractor, at his own expense, to the satisfaction of the Engineer.

Immediately prior to setting to work any item or part of the Contract works, the Contractor shall ensure that the item ready to test is thoroughly clean and free from dust, dirt, moisture and other foreign matter. In addition, he shall ensure that all other parts of the works involved have been adequately cleaned.

Any damage caused to systems or plant by the foregoing conditions not having been achieved shall be deemed to be the responsibility of the Contractor and shall be made good, at his expense to the satisfaction of the Engineer.

All pipework shall be accurately set out on site by the Contractor to the latest Contract drawings.

The Contractor shall make himself completely aware of all other services within the building which may affect his installation. No extra costs will be allowed for altered pipework which may be necessitated by non-observance of this clause.

j) Installation:

Installation of plant, equipment and materials shall be carried out in strict accordance with the recommendations of the manufacturers of the fittings, plant and equipment.

All tubing and materials to be incorporated into the works shall be stored under cover, clear of the ground and fully protected from the weather.

Jointing material must not project into the bore of the pipes, fittings or appliances.

Special care shall be taken to prevent dirt and rubbish entering the open ends of pipework during the progress of the work. Open ends shall be blanked off with purpose made metal plugs, polythene caps or blank flanges, plugs of wood, paper or any other materials shall not be used. Should the above requirements not be observed the Engineer reserves the right to order pipework to be dismantled, and cleaned internally or renewed as is necessary. Should any stoppage or restriction to the service fluid flow occur after a service has been put into operation, and the stoppage or restriction is due to the non-compliance with this requirement, the Contractor shall attend and rectify the matter at his own expense.

Where practicable, joints in pipework shall not be made within the thickness of walls, floors or roof, or where they could be built in.

Change of pipe sizes shall be made with taper fittings. On horizontal soil, waste and drainage pipelines eccentric pattern tapers shall be used, installed to produce level soffits.

All fittings shall be purpose made, compatible with the pipe materials and suitable for the working condition of the system.

Horizontal soil, waste or ventilation pipes to be installed to minimum falls as defined in BS 5572 1978. Horizontal ventilation pipes shall rise towards the main

ventilation pipe or fresh air terminal. They shall be installed above the spill-over level of appliances except where shown. Where connected to a main stack pipe, connect at a level above the spill-over level of the highest appliance connected to the stack pipe.

Connect branch ventilating pipes to branch soil or waste pipes within the limits of 75mm and 450mm from the crown of the trap.

No part of a drain shall be further from a manhole or inspection chamber than 45metres as measured along the pipe. Manholes or inspection chambers shall be provided on a branch drain within 12metres of a junction, unless there is a manhole at the junction. Ventilating pipes shall be provided as necessary to maintain the water seal in traps.

Fit seal ring adapters or seal ring expansion sockets to accommodate thermal expansion, as recommended by the pipe and fittings manufacturer. Do not mix pipes and fittings of different manufacture.

Junctions between two pipes shall generally be made with radius branch fittings swept in the direction of water flow.

j) Installation

Junctions between waste pipes and vertical soil pipes shall be made with bossed pipe connections, the boss being cast or moulded as an integral part of a fitting or pipe.

Access shall be provided at the base of each vertical stack, at junctions to horizontal branches of 50mm diameter and over, at bends, changes of direction and at suitable locations on straight horizontal runs to enable the complete disposal system to be inspected and tested for the clearance of any blockage. All access doors and rodding eyes shall be positioned to be completely accessible particularly in relation to the positions of adjacent services.

Before testing, all access doors to pipe fittings shall be removed, inspected, the seal rings lubricated and then re-assembled by the Contractor. Lubricant to be of a jelly consistency and compatible with the materials with which it will be in contact.

Access points on soil pipes shall be of the oval door pattern provided as an access fitting or incorporated on a branch fitting. Access points on waste pipes shall be of the rodding eye type.

k) Soil Pipe Terminals at Roof Level:

All soil and waste pipes where passing through roofs shall terminate with tile vents or ridge vents as its location determines. All terminations shall be air tight and waterproof. The tile vents and ridge vents shall be provided by the Main Contractor, and the Contractor shall connect to the terminal at the time of roof tiling or as requested by the Main Contractor.

Vertical pipes shall be erected truly parallel and plumb with vertical surfaces.

Pipework in ducts and ceiling voids shall be run so as to permit subsequent access to any pipe for maintenance or removal without disturbance to other pipes.

When positioned in ducts or together with other services the pipework shall be installed to provide adequate access for maintenance and repair for this and all other adjacent services.

Where a pipeline crosses a structural movement joint, provision shall be made within the pipework to accommodate potential horizontal and vertical movement.

The Contractor shall ensure that all pipework and fittings delivered to the site for inclusion in the works are stored in an approved manner to avoid deterioration due to accidental damage and atmospheric conditions.

Any part of the pipework installation which, in the opinion of the Engineer, is sub-standard, unduly distorted, marked by tools or in a deteriorated condition shall be removed and replaced at the Contractor's expense.

k) Soil Pipe Terminals at Roof Level:

Before final erection, all pipework shall be free of dirt or other forms of corrosion. Such defects shall be removed and the pipework made good in a manner approved by the engineer. Any blockage or restriction revealed after the pipework systems have been put into operation and which is attributable to neglect by the Contractor shall be rectified by the Contractor at his own expense.

Where passing through walls, foundations, etc., the Contractor shall install sleeves or ducts for the pipework, sealed at both ends.

Pipework buried below ground in corrosive soils shall be protected by double wrapping with an approved grease impregnated bandage wrapping tape, or other equal and approved material.

l) Plastic soil waste & ventilation pipes:

Fittings and pipes shall be provided by the pipe manufacturer as a complete system to ensure total compatibility between pipes and fittings. Mixing different makes of pipes and fittings will not be permitted. Construction and latent defects and any consequential damage arising from non-compliance with this Clause shall be rectified at the Contractor's own expense.

Primary jointing method shall be solvent welding. Solvents shall comply with BS6209 : 1982, and be supplied by the pipe and fittings manufacturer.

Expansion joints shall be of the telescopic pattern. Where required independently of other fittings, expansion joints shall comprise a straight expansion coupling incorporating a solvent weld socket plus a seal ring expansion socket, where provision for expansion joint occurs adjacent to a pipe fitting an expansion joint shall be formed by fitting a seal ring adapter to the relevant socket of the solvent weld fitting.

Rubber seal rings for expansion fittings and adapters shall be of a ribbed section giving more than one point of contact with the pipe. Material for seal rings shall meet the requirements of BS2494 : 1976.'O' section seal rings will not be permitted.

WC pan socket connectors shall incorporate a natural rubber WC pan seal ring. WC's in range shall connect to pipework with a WC pan manifold connector having an angled outlet. The angle of outlet shall be selected to suit the position of the WC along the length of the soil pipe manifold.

Pipes shall be cut with a hacksaw. Cuts shall be square, the ends cleaned of swarf and chamfered for easy pipe entry into socket of fitting.

Pipe ends and fittings shall be prepared and joints made strictly in accordance with the manufacturer's instructions.

k) Soil Pipe Terminals at Roof Level:

Overflows from WC flushing cisterns shall discharge to a noticeable position and their source clearly identified. Overflows from a range of WC's may be combined to form a common overflow having a minimum diameter of 25mm. Where overflow pipes are combined, each overflow pipe shall discharge into a tundish in a visible position such that there is an air gap between the point of discharge and the rim of the tundish. The tundish shall connect to the common overflow pipe which shall discharge outside an external wall or over a gully as required by the Water Authority. Overflows from WC's in more than one toilet area shall not be interconnected. The Contractor shall propose a proprietary system of overflows and tundishes for consideration. Where the discharge point of a warning pipe or overflow pipe is remote from a cistern, the source of such pipes shall be clearly labelled at or adjacent to the point of discharge.

Overflow and warning pipes may be PVC pressure pipes or half hard copper tubes.

m) Supports:

All supports, anchors and fixing accessories shall be provided by the Contractor. For items which are required to be attached to the surface of the building fabric by screws or similar the Contractor shall provide competent labour and suitable equipment for drilling and securing the support or fixing accessory. Approval of such work shall be given by the Engineer prior to its commencement.

Where supports require building into the building fabric the Contractor shall be responsible for accurately locating and marking the position of the supports and ensure that they are built-in to his requirements. Supports shall be built-in by others.

On soil waste and vent pipes thermal movement limiters shall be used in conjunction with pipe supports and expansion fittings to ensure that thermal movement is distributed evenly through all expansion fittings. All pipe brackets and thermal movement limiters shall be selected and fitted in accordance with the pipe system manufacturer's recommendations.

The Contractor may, at the discretion of the Engineer, use as a substitute for the described supports and brackets, a proprietary system of supports provided that full details and drawings are submitted to the Engineer for his approval.

Maximum distance between supports shall not exceed the dimensions given in the following table:

Pipe Material	Pipe (mm)	Maximum Distance Between Supports	
		Horizontal Pipes (mm)	Vertical Pipes (mm)
UPVC BS4514 32		500	1200
	40	500	1200
MUPVC	50	600	1200
	76	900	1800
	100	900	1800
	150	1200	1800

n) Pipes passing through structures:

Where pipes pass through internal walls and floors, sleeves shall be fitted to allow free axial movement of the pipes. Sleeves shall be of a material compatible to the pipe it protects, be non-combustible and of minimum bore to allow pipe movement and shall finish flush with the finished wall. Where passing through floors the sleeve shall project 40mm above floor finish. The annular space between the pipe and sleeve shall be packed with fire resistant material, so as to prevent passage of fire or smoke.

Where pipework of 50mm diameter or over penetrates structural walls or floors a fire collar shall be provided. The sleeve shall comprise of two half shells of sheet metal containing a barrier of intumescent material to fit around the pipe. These are clipped in position and anchored to the surrounding structure by brackets or cast into the walls or floors. The fixings shall be non-combustible.

Where pipework passed through internal walls, etc., the Contractor shall ensure that these pipes are not subsequently bedded-in by making good procedures adopted by other trades.

Where pipework passes through structural tanking or external walls made of waterproof concrete below ground level, the Contractor shall supply and cast-in puddle flanged sleeves into the structure.

Joints shall not be buried or concealed within the thickness of the building fabric, and where pipework passes through the structure a sleeve of similar material shall be installed.

o) Testing & Commissioning:

The Contract Works shall include the testing, commissioning and proving of all the public health services installations in accordance with the relevant British Standards. British Standard Codes of Practice, the recommendations of the Chartered Institution of Building Services Engineers (Great Britain), and the recommendations of the Institute of Plumbing.

The Contractor shall programme the work in conjunction with the Engineer and shall demonstrate to the satisfaction of the Engineer that the systems comply with the Specification in every respect.

The Contractor shall include in the Tender Price for the draining and where required the cleaning of all parts of the installation tested. The contractor shall include for the rodding of the whole drainage system on completion, including the existing to ensure the whole is clear of debris and blockages, to the satisfaction of the Engineer.

The testing of the Contract Works shall fall into two categories:

i) Works Tests

ii) Site Tests

Works tests shall be deemed to include all specified tests and inspections carried out before plant and materials are delivered to site in addition to the manufacturer's standard tests. A satisfactory test certificate shall be provided for the Engineer's approval.

Site tests shall be deemed to include all tests and inspections conducted on site on plant and installed service including inspections on plant and materials upon delivery to site.

Site testing is categorised as follows:

i) Static Inspection and Pressure Tests.

ii) Safety Inspection and Performance Tests.

The Contractor shall provide test certificates indicating service/ plant tested, type of test, test result and date of test. The certificates shall be signed by a responsible member of the Contractors staff and countersigned by the Engineer following the successful completion of the test. It should be noted that no item of plant shall be run or electrical system energised unless a 'safe to operate' certificate has been issued to the Engineer and acknowledged.

p) Test pressures:

Any internal rainwater pipes and the complete soil and waste pipe installation shall be subjected to an AIR pressure test of 38mm water gauge.

q) Defects:

All defects revealed by the tests shall be rectified at the Contractors expense. The fact that any part of the work has previously passed any test will not relieve the Contractor of any of his obligations.

Any defects shown by further or final tests or appearing during the defects liability period shall be corrected.

r) Builder's work drawings:

The Contractor shall provide the Engineer with fully detailed and accurately dimensioned builderswork drawings indicating any holes required through the building structure and where necessary through other building fabric elements. These drawings shall be approved by the Engineer before any work associated with them is undertaken.

These drawings shall be submitted in good time, for approval such that the programme shall not be delayed in any way whatsoever.

s) Record drawings:

The Contractor shall initiate at an early stage of the construction period a programme of compiling record "As Fitted" drawings and shall maintain such progress as to keep these drawings regularly up-to-date. The Contractor shall agree with the Engineer a start date for the preparation of the "As Fitted" drawings. Record drawing requirements shall generally be in accordance with Clause 2.28.

5.10 Holding Down Bolts

The Contractor shall provide and install all holding down bolts and nuts necessary for the fixing of the equipment supplied in this contract. Rawl plug or similar expanding fixings shall be drilled and fixed by the Mechanical Contractor. Where pockets are required i the building fabric these shall be formed by the Main Contractor. The Mechanical Contractor shall then provide and position holding down bolts for grouting by the Main Contractor.

5.11 Use of Dissimilar Metals

The Contractor will ensure that at no part of any open system does he include, either in contact or at a distance, dissimilar metals which will promote chemical or electro chemical action, causing a weakening or failure of the service. This applies not only to the internal surfaces, but also to the external surfaces of all pipes fittings, valves, plant, vessels, pumps and any other item of equipment in the installation. Where the use of adjacent dissimilar metals is required, for example, connections to existing services an electrically inert joint shall be incorporated between the two dissimilar materials.

5.12 Oils and Greases

The Contractor shall include for supplying the initial charge of all oils or greases for lubrication points on all items of equipment supplied under this Contract, and supplying all valve or gland packings and shall include for all necessary following up and topping up of these items to ensure that the correct levels and conditions are obtained at the time of handing over.

5.13 Labels and Charts

The Contractor shall supply and fix labels on all valves and stop cocks, on all pipework mains and sub circuits, air ductwork, dampers, controls and switches wherever necessary for identification of services.

Valve labels shall be of rigid plastic colour coded according to service with engraved or stamped lettering filled in with an approved composition, to provide a clear indication of the function of valves, instruments etc. The labels shall be affixed in positions by a non-ferrous metal chain.

Each label shall be numbered to agree with a Schedule of valves, etc., to be prepared by the Contractor in conjunction with the Record Drawings.

Each plant shall be provided with a manufacturer's label giving serial number, date, rated duty of equipment, test and working pressures, horse power, speed, amperage, voltage, phases, etc., to facilitate identification at a later date with ease.

All other items of equipment in plant and sub-plant rooms shall be provided with engraved fixed labels which shall describe the item of equipment and designate where there is more than one of similar type or purpose, e.g. "Heating Boiler No. 2", etc.

5.14 Maintenance Tools and Spares

Two sets of spanners, gland keys and other special tools required to test or dismantle such items of equipment as pumps, fans, etc., shall be provided by the Contractor. Two keys shall be provided for each size of lock shield regulating valve, air, plug and drain cock, automatic air valve or other valve requiring special tools to operate, together with duplicate keys for any locks on instruments safety valves, etc., supplied under this Contract. The tools shall be contained in a lockable metal tool box complete with a content list enclosed in a plastic envelope and padlock/key.

The Contractor shall supply in suitably sealed containers the following spares:

1. Sufficient oil, greases and water treatment dosing chemicals for full maintenance of all motors, bearings, etc., for a period of twelve months from the date of handing over.
2. 1 Set of bags/cells for all replaceable filters.
3. 1 complete spare set of belts for all belt driven equipment such as fans, pumps.
4. 1 set of cleaning tools for each and every boiler in other combustion appliances.

5.15 Manufacturers Servicing and Commissioning

The Contractor is to include in his Tender a definite sum for the initial servicing, checking over, testing and commissioning of the whole of the automatic controls, air handling plants, heating/cooling fan coil units, chiller plants, etc., by the respective manufacturers and the Tenderer must make it clear to all such manufacturers that they will be expected to carry out such work by their own Specialist Engineer on Site. Test Certificates in triplicate for these services shall be handed over to the Engineers.

5.16 Painting and Pipe Identification

All black steel pipework, unless otherwise specified together with steel hangers, brackets, supports, gantries anchors, guides, ductwork flanges, hangers stiffeners, etc., provided and erected under this Contract shall be painted with one coat of red oxide paint after erection, and before application of thermal insulation. Where exposed, these to be further painted in primer then 2 coats of black gloss topcoat.

All pipes and iron work to be painted shall first be thoroughly cleaned so as to be free of scale, rust, oil etc. Uninsulated nonferrous valve bodies shall be thoroughly cleaned and left unpainted.

All welds in steel mains, brackets, etc., throughout shall be wire brushed and the weld given one coat of red oxide paint for 25mm either side of the weld, soon after welding.

The painting shall include for all protective finishes throughout together with decorative finishes where specified.

All plant and equipment, control panel and other special items shall be delivered to Site with a Factory finish in accordance with this Specification. Where no finish is so specified, the finish shall be as the manufacturer's standard factory finish. All finishes shall be protected once delivered to Site.

The Contractor must ensure that work covered by this Contract is carefully programmed to ensure that damage to finished paintwork does not occur.

All pipework in ducts and in damp situations shall be painted two coats of red oxide before any insulation is applied.

The Contractor shall fix colour identification to all finished 'pipe lines. Colours to be BS1710 at 3m spacings on straight runs and at all access positions and all branches etc. in plantrooms, ceiling voids, risers, ducts etc. For the purpose of this Contract, the term 'pipe' lines shall be understood to include pipes, ducts and their coverings.

All colour identification of 'pipe' lines shall be applied as follows:

i) Primary Identification

Primary identification shall be in the form of rings not less than 300mm long at intervals not exceeding 10 m and at entry/exits through all fixed walls/floors. Each colour shall be coded to identify that particular service. Stick on bands will not be permitted.

ii) Detailed Identification of Contents

Direction of flow of all fluids shall be given on all 'pipe' lines and shall be in coloured plastic fixed to the 'pipe' lines near flanges, valves, junctions, walls, etc., and at such other positions as may be desired in such a manner as to be plainly visible at the angle from which the pipes are most likely to be viewed.

iii) Labels

Are to be provided for the identification of services to include control panels, field controls and sensors, valves, plant, fans, pumps etc. Labels to be to an approved pattern.

5.17 **Instrumentation**

The Contractor shall supply and install the following instrumentation:

a) Temperature Gauges

100mm diameter vapour pressure type temperature gauges shall be provided in the locations listed below. The temperature gauges shall be graduated 0 to 150°C for LTHW and DHWS services and 0°C to 30°C for CHW services with back or bottom entry to suit the location and shall be complete with mild steel pocket for LTHW and CHW pipework and gunmetal pocket in DHWS pipework.

The thermometers shall be manufactured by Coley, British Rototherm or GN Seal approved.

Temperature gauges shall be provided in the following positions:

1. At the flow and return of each boiler/water chiller.

2. At common flow and return circuits.

3. As shown on the drawing or elsewhere in this specification.

b) Pressure Gauges

100mm diameter gauges shall be provided at all pump suction and delivery connections and for each boiler and shall be of the same manufacture as the thermometers and of matching appearance. Pressure gauges shall be graduated in bars to cover a range approximately 1.5 times the normal operating pressures expected from the system and shall be complete with a loose red pointer set at the normal operating pressure position.

Altitude gauges for boiler plant shall be graduated in bar and meter head and have the loose pointer set at the normal static head pressure.

All gauges shall be direct pipeline mounted with a 100mm gunmetal gauge cocks and siphon unless specified as remote mounted. Where remote mounted gauges are required these shall be fixed to 25mm thick polished hardwood panels in appropriate locations and labelled for "suction" and "delivery" together with service identification. Connections to the system shall be formed from 10mm soft copper neatly clipped to walls and brackets.

Pressure gauges shall be provided at all pump suction and delivery connections.

c) Testing Points

Pressure/Temperature testing points, as manufactured by Binder Engineering, type Twinlock universal test plug shall be provided in the following positions:

1. On the flow and return connections of all heater and cooler batteries.

2. On all ports of all three port control valves.

3. On the inlet and outlet port of all four port control valves.

4. On the suction and discharge of all circulating pumps.

5. On the flow and return to all boilers and refrigeration plants.

5.18 **Chlorination and Legionella Risk Assessment**

The Contractor shall thoroughly flush and then chlorinate the whole water system in accordance with HSC ACOP L8 (Legionnaires' disease) and BS6700 prior to completion and provide test certificates on completion to prove that the whole is in satisfactory condition. The Contractor shall check the following:

- Cold water storage temperatures of CWS tank(s).
- Cold water draw-off temperatures at each outlet after 2 minutes.
- Hot water draw-off temperature at each outlet after 1 minute.
- Storage temperatures of calorifier(s).

- HWS return water temperature at calorifier(s) and peripheral branch returns.

The results of the Legionellois risk reduction test should clearly identify each and every outlet and component for future reference, together with time and temperature result. The identification may be in the form of layout drawings with notes or tabulated with reference diagram.

5.19 **Energy sub meter**

Sub-metering of energy consumption shall be provided in accordance with the Building Regulations. Sub metres shall be provided and installed by the contractor to measure the input power consumption of all boiler plant over 50kW, chiller plant over 20kW and electric humidifier over 10kW, in accordance with Building Regulations approved document L2 table 13.

The particular section of this specification may also require sub-metering for:

a) Separately tenanted spaces
b) Building over 500 m² on multi building building sites
c) Any process load which has been discounted when comparing consumption against published benchmarks

APPENDIX A – TENDER ANALYSIS

SUMMARY OF TENDER – ELECTRICAL SERVICES

PROJECT TITLE: Birstall Community Hall, Leicester

JOB NUMBER: 170062

THIS SHEET MUST BE COMPLETED IN FULL AND RETURNED WITH TENDER

The Contractor shall complete in the space below, the costs associated with the design, supply, delivery, installation, testing and commissioning of the following elements:-

ELECTRICAL SERVICES		
1.0	**Preliminaries**	£
2.0	**Design development and Drawing Production**	£
3.0	**Attendance for new incoming supplies Supply**	£
4.0	**Low Voltage Switchgear**	£
5.0	**Earthing and Bonding**	£
6.0	**Cable Containment and Wiring System**	
6.1	Cable Containment	£
6.2	Sub-Main and Final Circuit Wiring	£
7.0	**Small Power**	£
8.0	**Lighting and Control System**	
8.1	Lighting Installation	£
8.2	Lighting Control System	£
9.0	**Intruder Alarm System**	£
10.0	**CCTV Installation**	£
11.0	**Fire Alarm System**	£
12.0	**Voice and Data Installation**	£
13.0	**Lightning Protection**	£
14.0	**Disabled Toilet Alarm**	£
15.0	**Hand dryers**	£
16.0	**Record Drawings, Client Instruction ,O&M Manuals and Log Book**	£
17.0	**Testing and Commissioning**	£
18.0	**Provision of Maintenance and Spares during 12 months defect period**	£

19.0	**Any Other Items not Mentioned Above (please identify)**	
	Provisional Sums	
20.0	Access Control System	**£3,000.00**
21.0	Main Hall – Projector, Projector Screen, Speakers, Cabling etc.	**£5,000.00**
22.0	**Total Electrical Services**	**£**

SUMMARY OF TENDER – MECHANICAL SERVICES

PROJECT TITLE: Birstall Community Hall, Leicester

JOB NUMBER: 170062

THIS SHEET MUST BE COMPLETED IN FULL AND RETURNED WITH TENDER

The Contractor shall complete in the space below, the costs associated with the design, supply, delivery, installation, testing and commissioning of the following elements:-

MECHANICAL SERVICES		
1.0	**Preliminaries**	£
2.0	**Design development and Drawing Production**	£
3.0	**Heating Installation**	
3.1	Gas-fired Boilers & flues	£
3.2	Heating circulation pumps	£
3.3	Underfloor heating system, inc. all necessary valves, manifolds and fittings etc.	£
3.4	Entrance area air curtain	£
3.5	Testing and commissioning	£
4.0	**Gas**	
4.1	Internal gas pipework including all necessary valves and fittings	£
4.2	Gas solenoid valve	£
4.3	Gas safe system for boiler	£
4.4	Gas ventilating grilles	£
4.5	Testing and commissioning	£
5.0	**Ventilation**	
5.1	Air handling unit, including controls and sensors	£
5.2	Attenuators	£
5.3	Supply and extract grilles	£
5.4	Ductwork, ductwork supports, VCDs etc.	£
5.5	Toilet extract ventilation	£
5.6	Kitchen supply and extract fans, including controls and sensors.	£
5.7	Ductwork, ductwork supports, VCDs, fire dampers etc.	£
5.8	Ductwork insulation	£
5.9	Door transfer grilles	£
5.10	Supply and extract louvres	£
5.11	Testing and commissioning	
6.0	**Domestic Water Services**	
6.1	Cold water pipework, valves, brackets etc	£
6.2	Electric hot water heaters	£
6.3	Thermal insulation of pipework	£
6.4	Testing and commissioning	£

7.0	**Above Ground Drainage**	
7.1	Above ground drainage including all fixtures and fitting required and final connection.	£
7.2	Testing and commissioning	£
9.0	**Provision of Maintenance and Spares during 12 months defect period**	£
10.0	**Any Other Items not Mentioned Above (please identify)**	£
	Total Mechanical Services	**£**

APPENDIX B – DOCUMENT AND DRAWING ISSUE REGISTER