



Manchester Central University NHS Foundation Trust
Manchester Royal Infirmary

CSB1 – AMR Laboratory
Performance Specification for Mechanical Services

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SECTION 1

PARTICULAR SPECIFICATION

1.1 DESCRIPTION OF WORKS

1.1.1 Introduction

The scope of works for this element of the contract shall be the complete **design, supply, installation and setting to work** of the Mechanical Building Services Works as described in the tender documents.

1.1.2 General Description

The project consists of the remodelling of an existing Laboratory on the second floor of the CSB1 Building at the Manchester Royal Infirmary. The works are being undertaken on behalf of Equans.

This performance specification covers the design and build aspect of the mechanical services including the complete fit-out of the laboratory including the provision of new items of mechanical plant on the roof of the building.

Provided within this tender package are Mechanical design proposals which are provided as an aide to the contractor's complete final design works. Also enclosed are some plans indicating existing services where these have been made available. These existing plans are not complete; it is therefore the contractor's responsibility to undertake further surveys works of the existing areas and produce their own set of existing as-built drawings. The drawings enclosed are for information only.

The Mechanical Engineering Services Contractor (referred to in this specification as the Contractor or Mechanical Services Contractor) shall include for the works to be designed, installed, set to work, commissioned, and first year's maintenance as per this specification; should the Contractor want to put forward any alternate methods of systems design, alternate manufacturers, etc. then these will be considered post-tender.

The Contractor shall make themselves aware of the Main Contract Preliminaries and Conditions of Contract.

The Contractor shall also refer to the standards sections specification noting that this Particular Specification overrides the General Standard Sections.

1.1.3 Access / Permit to Work / Shutdowns

Refer also to the Main Contract documentation for details of access and permission to work requirements. The Trust operates a permit to work system which will have to be complied with for all work outside the nominated work area and for all work affecting other services. A hot work permit will also have to be issued by the client for all welding, brazing, etc. The Contractor's attention is particularly drawn to the nature of the site in that areas around the Contract are fully operational, and will remain in operation throughout the duration of the contract. Access will be required to other areas to carry out the provision of Mechanical services.

The contractor shall arrange for and carry out all shutdowns in close cooperation with the Client and the Trust. Two weeks' notice is required, by the Client, of the intention to isolate and break into existing services. The exact evenings/weekends for this will be given by the Trust.

A schedule of proposed shutdowns shall be provided by the Contractor for the first site meeting. This shall be updated and re-issued throughout the Contract when requested and for all site meetings.

1.1.4 Visit to Site

In liaison with the Main Contractor the Mechanical Contractor must visit site to assess the extent of the works as no claim on the grounds of want of knowledge in such respect will be accepted.

Prior to visiting site the Contractor shall obtain permission from:-

Mr Ian Farrow (Project Manager)
Equans

Tel N°: 07812 509639

1.1.5 Existing Services and Survey

Existing site drawings are included within this tender package. These drawings indicate some of the existing services. Access to the ceiling voids has not been feasible, therefore it is the contractor's responsibility to undertake further surveys and to ensure that they have included for the removal of all existing mechanical services within the area of works, i.e. The Fracture Clinic, Riser Spaces, the plantroom areas, and the roof. The accuracy of any existing drawings included within the package of works is unknown and the exact locations of existing services are to be assessed on site by the contractor during the contract works.

1.1.6 Brief List of Mechanical Services

The Mechanical Services work briefly includes the design, installation, setting to work and commissioning of all mechanical building services. The contractor shall include for full coordination will all aspects of the new construction works, included electrical services, structural elements, and the architectural details.

The method of services to the new facility is to be determined by the mechanical contractor however it is expected to be as described in the following clauses:

- **Design Duties**

Provide all design, construction, fabrication and installation drawings, as defined in Section 3 of this specification, and design calculations for comment.

- **Builders Work**

The production of Builders Work information as defined in Section 3 of this specification.

- **Removal/Modification of Existing Services**

Remove all existing redundant mechanical services.

- **Domestic Hot and Cold Water**

Strip out all existing, and connect into existing hot and cold water services and provide new to a new wash hand basin.

- **Heating**

Strip out all existing.

- **General Ventilation**

Provide new local heat recovery unit within the ceiling void of the laboratory to provide a minimum of 10 air changes per hour within the lab. Supply and extract ductwork to be connected to new external louvres.

Provide new LEV system connected to a new safety cabinet. Provide door transfer grille to allow make-up air into the room from surrounding corridors.

- **Above Ground Drainage**

Remove existing and provide new to allow installation of a new wash hand basin.

Provide drainage to the heat recovery unit and AC system.

- **Air Conditioning**

Provide new AC system to provide heating and cooling to the new laboratory. Ceiling mounted cassette to be provided with condenser mounted on the roof.

- **Building management System (BMS)**

Connect new heat recovery unit and AC System to the BMS for fault monitoring purposes.

- **Testing and Commissioning**

Test, commission and set to work the Mechanical services after completion of works. Include results in the record documents.

- **Record Documents**

Provide Record Documents (including test certificates and 'As Installed' drawings) as detailed in Section 3 of this Specification.

- **Client Demonstration**

Demonstration for the client or client appointed staff in operating, maintaining and servicing all the associated plant.

- Liaison with The Trust for shutdowns, connections into existing.
- Liaising and co-ordinating with other Contractors and the Consultants.
- Production of Method Statements as defined in Section 3 of this specification.
- The production of all other information / drawings / training required by this specification and the main Contract documentation.

All plant shall be so installed such that it complies with CDM and Health and Safety guidance on access and good maintenance.

1.2 CONTRACTORS DESIGN OBLIGATIONS AND STANDARDS

1.2.1 General

The Mechanical Contractor shall be responsible for the full detailed design, installation and commissioning of all necessary Mechanical Building Services to suit the building layouts and as outlined within this specification and as shown on the Main Contractors design proposal Drawings.

The Mechanical Contractor shall provide the design to the full duties as defined by the Association of Consulting Engineers Agreement B (2). All design information given are minimum requirements and do not relieve Mechanical Contractor of his/her obligations to design service systems to satisfy the contract conditions.

This section of the Performance Specification details the design standards that the Mechanical Contractor shall be required to adhere to in the development of the design and installation of the Mechanical Services on this project. It should not be taken as being exhaustive, but it is indicative of the quality and standards required for the project.

In addition to the accompanying tender documents, this document is to be read in conjunction with the Main Contract Prelims and the General Conditions, Project Sectional Completion Strategy and Plans, and all associated project manager and architectural documentation.

This overall specification includes references to builder's work requirements to enable the building services to be installed efficiently and as an integrated part of the whole building and site development. It is the responsibility of the Main Contractor bidding for the project to ensure that all aspects of this document are complied with regardless to the Sub-Contract chain involved in the construction project.

The Construction Programme will be issued by the Project Manager as part of the tender documents.

1.2.2 Standards Applicable

All systems shall be designed, selected, manufactured, installed, commissioned and set to work in accordance with the latest version of all applicable guidance and codes of practice documents including the following. This list may not include all relevant guidance which must be adhered within the contractor's design proposals: -

- British Standards
- Building Services Research & Information Association (BSRIA) documents
- Building Regulations
- Building Research Establishment (BRE) documents
- CIBSE Guides, Application Manuals, Energy Codes, Commissioning Codes, Guidance Notes, Knowledge Series and Technical Memoranda
- NHS Publications (HTMs, HBNs, etc.)
- HVCA Ductwork Publications

Some of the key standards are detailed in this specification. A schedule of documents seen to be particularly relevant is included below for information (Note - This schedule may not indicate all relevant items and does not constitute a reduced list that has to be complied with): -

British Standards

BS 1192	Collaborative production of architectural, engineering and construction information. Code of practice
BS 5682	Specification for Probes (quick connectors) for Use with Medical Gas Pipeline Systems
BS 7671	Requirements for Electrical Installations (IET Wiring Regulations 17 th Edition)
BS 8536-1	Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure)
BS 8536-2	Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure)
BS 8542	Calculating Domestic Water Consumption in Non-domestic Buildings – Code of practice
BS 8558	Guide to the Design, Installation, Testing and Maintenance of Services Supplying water for Domestic Use within Buildings and their Curtilages – Complementary Guidance to BS EN 806
BS 9999	Code of Practice for Fire Safety in the Design, Management and Use of Buildings
BS EN 806	Specification for Installations Inside Buildings Conveying Water for Human Consumption
BS EN 12056	Gravity Drainage Systems Inside Buildings
BS EN 12236	Hangers and Supports
PAS 1192-2	Specification for information management for the capital/delivery phase of construction projects using building information modelling
PAS 1192-3	Specification for information management for the operational phase of assets using building information modelling (BIM)
BS 1192-4	Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice
PAS 1192-5	Specification for security-minded building information modelling, digital built environments and smart asset management
PAS 1192-6	Specification for collaborative sharing and use of structured Health and Safety information using BIM

Building Regulations

Part B	Fire Safety
Part F	Ventilation
Part G	Sanitation, Hot Water Safety and Water Efficiency
Part H	Drainage and Waste Disposal
Part L	Conservation of Fuel and Power

The Chartered Institution of Building Services Engineers (CIBSE) Guide

Guide B: Heating, Ventilation, Air Conditioning and Refrigeration

Knowledge Series

CIBSE KS7 Variable flow pipework systems.

Health Building Notes

HBN 00-02	Sanitary Spaces
HBN 00-03	Clinical and Clinical Support Spaces
HBN 00-04	Circulation and Communication Spaces
HBN 00-07	Resilience Planning for Healthcare Estate
HBN 00-08	Estatecode
HBN 00-09	Infection Control in the Built Environment
HBN 11-01	Facilities for Primary and Community Care Services
HBN 12-01	Out-patient Care – Consulting, Examination & Treatment Facilities
HBN 04-01	In-patient Care – Adult In-patient Facilities (December 2009)
HBN 6	Volume 1: Facilities for Diagnostic Imaging and Interventional Radiology
	Volume 2: Diagnostic Imaging: PACS and Specialist Imaging
HBN 4	In-patient Accommodation Options for Choice Supplement 1 (February 2005)
HBN 03-01	Acute Mental Health Units (2013)

Health Facilities Notes

HFN 30	Infection Control in the Built Environment – Design and Planning
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Health Technical Memoranda

HTM 00-01	Policies and Principles – Best Practice Guidance for Healthcare Engineering
HTM 02-01	Medical Gas Pipeline Systems
HTM 03-01	Heating and Ventilation Systems – Specialised Ventilation for Healthcare Premises
HTM 04-01	Water Systems – The Control of Legionella, Hygiene, “Safe” Hot Water, Cold Water and Drinking Water Systems
HTM 04-01	Addendum: Pseudomonas Aeruginosa – Advice for Augmented Care Units
HTM 05-01	Firecode – Fire Safety in the NHS – Managing Healthcare Fire Safety
HTM 05-02	Firecode – Fire Safety in the NHS – Guidance in Support of Functional Provisions for Healthcare Premises
HTM 05-03	Firecode – Fire Safety in the NHS – Operational Provision
HTM 06-01	Electrical Services – Supply and Distribution
HTM 06-02	Electrical Services – Electrical Safety Guidance for Low Voltage Systems
HTM 06-03	Electrical Services – Electrical Safety Guidance for High Voltage Systems
HTM 07-01	Environment and Sustainability – Safe Management of Healthcare Waste
HTM 07-02	Environment and Sustainability – EnCO ₂ de – Making Energy Work in Healthcare
HTM 07-03	Environment and Sustainability – Transport Management and Car-Parking
HTM 07-04	Environment and Sustainability – Water Management and Water Efficiency – Best Practice Advice for the Healthcare Sector
HTM 08-01	Specialist Services – Acoustics
HTM 08-03	Bedhead Services

Heating & Ventilation Contractors' Association (HVCA)

DW/143	A Practical Guide to Ductwork Leakage Testing
DW/144	Specification for Sheet Metal Ductwork
DW/154	Specification for Plastic Ductwork
DW/191	Code of Practice for Resin-bonded Glass Fibre Ductwork Metric
TR/19	Guide to Good Practice: Internal Cleanliness of Ventilation Systems
TR/20	Installation and Testing of Pipework Systems

European Union

Commission Regulation (EU) N° 1253/2014

The above standards are continually being updated, with new standards also becoming applicable. The Mechanical Sub-Contractor shall ensure that the specialists / personnel completing the manufacturing / installation works are familiar with the latest standards applicable at Tender and completes all works in accordance with these standards.

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

The Contractor shall also be aware of and comply with the following: -

- Main Contract Conditions
- Architects, Structural, Mechanical and Electrical Drawings
- Room data sheets
- All associated Tender documentation
- Health and Safety at Work Act and associated regulations including the Electricity at Work Regulations, COSHH and the Prevention and Control of Legionella.
- Construction (Design and Management) Regulations
- All current local water authority Byelaws & current Water Industry Specifications including Water Supply (Water Fittings) Regulations 1999.
- L8 Legionnaires Disease, The Control of Legionella Bacteria in Water Systems – Approved Code of Practice and Guidance.
- All current gas safety regulations including Gas Board Requirements and the Institute of Gas Engineers documents.
- Design to fully meet the requirements of the local Environmental Health Officer, Fire Officer and Building Control Officer. These requirements being incorporated over and above any minimum standards given in this document.
- Employer's Requirements, Schedule of Accommodation and Room Descriptions/data sheets (document attached).
- Loss Prevention Council Rules
- The requirements of the Clients Insurance Company
- Ventilation philosophies to meet the requirements of the local building control officer as regards occupancy levels and fresh air rate per person; and the requirements outlined under the BREEAM Pre-Assessment.

This is a performance and quality specification only and does not set out to be fully comprehensive. The Mechanical Contractor shall include all works necessary for the correct functioning of the equipment therein.

Installed systems shall be “energy efficient” with selection of systems based on whole life costings as opposed to initial capital cost. Life cycle costings shall take into account the effects of the Climate Change Levy.

Systems and equipment shall always where ever possible be selected from the Energy Technology Product List and be eligible for the Enhanced Capital Allowance Scheme (www.eca.gov.uk).

Installed systems shall be readily accessible and located so that future plant maintenance can be achieved safely. Replacement of plant will also be achievable safely and without major difficulty.

All mechanical plant shall be so located and selected to ensure that the Acoustic Consultants Guidance on noise levels are not exceeded.

All major plant should also be installed at a level above that perceived as the design flood level as specified elsewhere. If required, plant shall be installed on raised platforms / podiums. Access to plant for maintenance and replacement shall be fully considered.

Where services are insulated, the insulation used shall be of a non-combustible type or an LPC approved material.

Quality of installation and workmanship shall be good and comply with all recognised industry / institutional standards.

Installed systems shall be suitable for a minimum system life of twenty years.

The Mechanical Contractor shall allow for the demonstration of the compliance with Part L of the building regulations, along with providing Pre-Construction and Post Construction Compliance reports to The Engineer and Building Control.

1.2.3 Reference to Other Sections of This Specification

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

1.3 GENERAL DESIGN AND CONSTRUCTION REQUIREMENTS

1.3.1 Engineers

At tender stage the Services Contractor shall submit his proposal detailing whom shall be undertaking the design of the services installations.

In addition, the Engineer(s) shall be required to visit site during site construction procurement at least at the following intervals

- a) on monthly intervals to overview the installation and ensure that the installation is progressing in accordance with the design proposals and report to main meetings. Provide a written comprehensive report for the same detailing any non-compliances or problems.
- b) on a weekly basis as above but to report at subcontract meetings
- c) during the commissioning stages of each incremental sub phase to witness both the mechanical and electrical commissioning and act as a professional interface between the contractor and the client team.

The Engineer(s) shall also overview commissioning of the completed project on a block by block basis once all sub phases have been completed and check all results prior to being forwarded to the Clients agent.

1.3.2 Review of Service Zones and Plant Areas

The Mechanical Contractor shall review the Main Contractors proposed drawings during the tender process to ensure that adequate space is provided for services installations in terms of initial installation, maintenance and future replacement, any additional costs incurred for the mechanical services to be contained within the provided service zones shall be included by the Mechanical Contractor.

The Services Contractor shall provide 3D AutoCAD drawings for all plant rooms, ceiling voids, risers and congested areas of services.

Adequate allowances shall be made when locating services to allow easy and safe access for maintenance and inspection, to fully comply with current Health and Safety Regulations and CDM.

1.3.3 Location of Services

All plant and equipment shall be located in plant rooms / risers dedicated for this purpose.

Services distribution shall be generally concealed in risers / ceiling or floor voids as appropriate.

Services shall be accessible for inspection / maintenance in all cases.

All distribution pipework shall be run within service ducts, roof, floor or ceiling voids. All pipework droppers shall drop within service ducts, locations to be agreed with the Architect, Main Contractor and the Building Services Engineer. All other droppers from the ceiling void must be agreed with the Architect and pipework shall be concealed to Architect detail.

The Mechanical Contractor shall utilise raised floor voids if available; for pipework distribution.

All radiators shall be designed to fit below windows where possible (apart from where only provided in circulation areas).

All ductwork shall run within roof or ceiling voids. All ductwork droppers shall drop within service ducts, locations to be agreed with the Architect, Main Contractor and the Building Services Engineer.

1.3.4 Provision for Access for Maintenance Purposes

Access to all plant and equipment for maintenance purposes shall be in accordance with CDM.

Under no circumstances should services be located such that they cannot be easily removed, serviced or replaced.

1.3.5 Acoustics

The mechanical services installation shall be designed to meet the acoustic requirements as given in the relevant design guides to fully satisfy and comply with recognised current practice and standards.

Particular attention must be paid to the design of rotating machinery anti-vibration mountings to ensure noise is not transferred through the structure. Vibration isolation shall be provided to limit noise levels to those given.

Careful attention shall be given to the design of fan units to limit noise breakouts from both fan boxes and ductwork components prior to any silencing. Breakouts shall be limited to ensure noise levels do not exceed levels detailed elsewhere in this brief.

Attenuation shall be provided to all ductwork systems to ensure noise levels do not exceed those given or relevant design guides. Particular attention shall be given to the strict requirements for eliminating cross talk potential in various locations.

Where ambient noise levels are specified relative to existing ambient, the Mechanical Contractor shall include for completing all necessary noise surveys prior to works commencing in order to ensure that the plant and equipment can be correctly designed to achieve the current design standards and Local Authority Planning requirements, whichever is the most onerous.

Acoustic treatment to building fabric and all services etc. must be provided to achieve the sound levels specified above.

Upon completion of the project the acoustic performance of the scheme must be measured and verified by the Commissioning Engineer, all as detailed in the Commissioning Section of this Specification.

1.3.6 Fire Precautions

Due allowance shall be made for the inclusion of all necessary fire/smoke dampers, pipe/fire sleeves and the like where services pass through fire compartments and floors.

The Mechanical Contractor shall ensure all items are included to comply with Building Control, Fire Department and site fire officer requirements.

1.3.7 Design Development

Any Architect's and Structural Engineer's drawings provided in the main contract tender documents are to be used for tendering design purposes. The Mechanical Contractors shall refer to the relevant Main Contract Documents for detailed information.

The Mechanical Contractor shall be fully responsible for the design of the mechanical installations and shall join a Design Team consisting of a Main Contractor along with his Sub Contractors, Structural Engineer and Architect, all with full design responsibility.

The Mechanical Contractor shall base his tender upon information detailed within this Performance Specification, information from the Main Contract and any relevant design guides stated, all of which shall not be taken as being exhaustive, but as indicative of the quality and standards required for the project.

This Performance Specification document gives design criteria, such as ventilation rates, space temperatures, noise levels etc. Should any of the information from this source be found to be incompatible or ambiguous, then the Mechanical Contractor shall raise the query during the tender period, or include for the most onerous option available.

The lead Mechanical and Electrical co-ordination role shall be undertaken by the Mechanical Contractor. The Mechanical Sub-Contractor shall obtain all layout drawings from the Electrical Contractor, and all other Sub Contractors to the Main Contractor, to include upon the fully co-ordinated working drawings.

The Mechanical Contractor shall be responsible for the production of design drawings, installation drawings, record drawings, builders work drawings and 'As Fitted' drawings as detailed elsewhere in this Specification.

The Mechanical Contractor shall be responsible for any design work associated with producing builders work drawings and all builders work information associated with the mechanical installations.

The Mechanical Contractor shall allow for attending any meetings necessary to provide full design and co-ordination of the mechanical installation with all other trades.

The Mechanical Contractor shall assess all riser sizes, void depths and service routes ensuring that the Architect is fully aware of their requirements and accommodate them. All voids, risers and service routes shall offer suitable access in compliance with current CDM requirements and shall be suitably sized for periodic maintenance to be successfully performed.

Where pipe and duct routes etc. are shown on the tender drawings, these are indicative routes and the Mechanical Contractor shall allow for any necessary bends and diversions to allow for the structure of the building, existing trees, landscaping etc. and co-ordinating the installation with all other trades.

The Mechanical Contractor shall liaise with the Principal Contractor for all architectural, structural and mechanical services drawings, specifications, sections, fire plans. Fire compartments, walls, structural work, phasing, controls etc.

1.3.8 Compliance with Part L of Building Regulations

The Mechanical Services Contractor shall be responsible for taking the lead role in achieving full compliance with Part L of the Building Regulations, this shall include:

1. Initial meetings to agree assumed fabric performance with remainder of team.
2. Production of Part L model utilising accredited level 5 software.
3. Review / development of model with remainder of design scheme to achieve compliant scheme with a margin to ensure that compliance can still be achieved at completion.
4. Produce summertime temperature report using thermal modelling (see detailed requirements for thermal model) as necessary in order to demonstrate compliance with summertime temperatures. The summertime temperature report shall show compliance with the requirements of the CIBSE's Technical Memorandum 52.
5. Produce a report for issue to building control covering all Part L criteria.
6. Meet with Building Control to present and agree report, providing clarification as necessary.
7. Provide advice to design team on any changes through the contract period where these will impact upon the building with regard to Part L compliance, any compromises with one element must be negated by improvements elsewhere within the overall design such that the building as a whole remains fully compliant.
8. Update model and report to incorporate as constructed details and test results and submit to building control at completion.
9. Provide and submit (once any comments have been incorporated) an Energy Performance Certificate (EPC).
10. The Services Contractor is required to produce for the building, a Display Energy Certificate following the soft landing post completion activities.

Where an initial model is included in the tender documentation this is provided to show one method of achieving compliance only, actual performance shall be proven by the model provided by the Services Contractor (the model supplied with the tender documentation shall not be used as the basis for the final model as this must be based on the detailed design).

1.3.9 Provision of Design Information

During the detailed design process the Mechanical Contractor shall provide the following information for each service (Including works designed by specialist sub-

contractors) in good and adequate time for comment by the client team such that comments may be incorporated into the final design and construction process:

1. Final design philosophy statement on a service by service basis, along with any assumptions made.
2. Detailed calculations to determine size of plant / equipment including, but not limited to the following:-
 - Heat losses and total heating load, including infiltration and ventilation losses.
 - Heat gains and total cooling load, including infiltration, equipment, solar and people.
 - Overheating calculations utilising IES Software or similar.
 - Fan sizing calculations including pressure drop analysis of all existing duct installations forming a part of this contract.
 - Pump sizing calculations for all heating, domestic hot water and chilled water pumping circuits.
 - Heating & cooling coil sizing calculations.
 - Low pressure hot water pipework and equipment sizing calculations including heat emitters, pipework, pumps, heat exchangers and so on.
 - Hot and Cold Water pipework and equipment sizing calculations including storage vessel size, tank size and heat recovery rates.
 - Chilled water pipework and equipment sizing calculations including fan coil units, pipework, pumps, heat exchangers and so on.
 - Controls wiring diagrams and philosophies along with point to point wiring diagrams and full controls logic diagrams.
3. Detailed and complete schematic drawings on a service by service basis all fully sized.
4. Distribution systems design drawings to include flow rate, velocity, resistance, residual pressure and reference for each section / leg.
5. Philosophy drawings as necessary to demonstrate detailed design (i.e., preliminary plant room layouts, pressure cascades etc.).
6. Commissioning engineers report on the ability to commission services.
7. Results from design packages such as Hevacomp, IES etc. with sufficient information to demonstrate input data and a summary of results.

All of the above information/documentation shall be issued to the Project Manager early on in the contract for comment prior to installation of the services, and further issued through the contractual loop to the Building Services Engineer for comment.

The Clients Building Services Engineer shall be given the opportunity to comment upon the aforementioned design documents and shall require two working weeks to review and pass comments.

As previously stated, calculations shall be submitted for comment prior to any installation works commencing on site. Any works that do commence without the submission of the relevant calculations/schedules being submitted, shall be deemed to have been undertaken at the contractor's risk and any installations subsequently

found to be of non-conformance with the design parameters, shall be rectified entirely at the Electrical Contractor's/Mechanical Contractor's expense with no detriment to the programme.

Any comments made shall be addressed and clarifications issued / agreed or design modified and re-issued for comment as appropriate. Engineers comments shall not relieve the Mechanical Contractor of any of his design responsibilities for the services installations and do not constitute an Approval status.

The Mechanical Contractor shall produce a schedule of all comments received along with details of agreed actions taken or clarification to resolve any issue raised. The schedule shall be a "live" document updated on a regular basis as the design develops and the commenting procedure progresses.

Drawings shall not be re-issued for further comment until all previous comments have been satisfactorily resolved and any amendments necessary incorporated.

The above process shall be fully completed prior to commencing the production of the fully detailed and co-ordinated working drawings all as detailed elsewhere within this specification.

1.3.10 Builders Work Drawings

- a) Based on the installation drawings, 4 copies will be required for comments and a further 6 copies of approved drawings for construction.
- b) Refer to the Contract Preliminaries for more specific requirements.
- c) To show all builders work requirements including louvres and incoming services.

1.3.11 Record Drawings

- a) The requirement for record drawings is set out in other sections of this Specification, but they should be based on the installation drawings.
- b) 1 print of the record drawings will be required for comment.
- c) 4 prints of the final drawings plus a copy in electronic format are required by the Employer. The 4 sets of prints will be folded, inserted into plastic wallets and incorporated in the maintenance manuals. 4 copies of the maintenance manuals are required.
- d) Latest version of AutoCAD DWG and PDF versions of the drawings shall also be included within the O&M.

1.3.12 Specialist Suppliers Drawings

- a) 2 prints are to be provided for comment.
- b) 4 copies of the final drawings are required for construction.
- c) 4 copies of the record drawings are required for the O & M manuals plus the latest version of AutoCAD DWG and PDF versions.

1.3.13 O & M Manuals

- a) The requirement for O & M manuals is set out in other sections of this Specification.
- b) 4 copies of the manuals are required, to include record drawings as outlined above.
- c) 4 electronic CD copies of the manuals in PDF format indexed to read as per a hard copy of the manual. As installed drawings shall also be provided on the discs in the latest version of AutoCAD drawing format.
- d) The O & M manuals and record drawings shall be compiled during the contract and be available for the first commissioning of the engineering services.

1.3.14 CDM Regulations

- a) 4 copies of Method Statements for dealing with Specific Risks.
- b) 4 Copies of Health & Safety information as required by the Regulations for incorporation into the Health & Safety File.

1.3.15 Technical Information to Be Supplied During Design Development

1. Information specifically requested for overall co-ordination: -
 - Programme
 - Quality Control Statement
 - Security/Confidentiality
2. A detailed specification for the following: -
 - Controls Installation
 - Ventilation Installations
 - Pipework Installations
3. Full detailed schematic drawings for all services with detail included to show: -
 - All Controls Interfaces
 - All Zone Controls
 - All Switchgear, Distribution Boards, Motor Control Centres
 - Phases
4. Schedule or notes on schematics giving full sizing details and calculations of all major items of plant and equipment (i.e. boiler output, etc.,) include: -
 - Heat Emitters
 - Pumps
 - Tanks
 - Air Handlers
 - Chillers
 - Fans
 - Switchgear
 - Motors
 - Valves
5. Plan drawings at 1:20 minimum scale to show all pipe and duct layouts all fully sized and fully co-ordinated with each other and building fabric and layout.

6. Drawings (1:20) fully co-ordinated.
7. Details (1:20) to be shown for all plant room areas and all ceiling voids for: -
 - Equipment Fits Within Areas
 - Access For Maintenance
8. Complete specification details of solutions selected for: -
 - Automatic Controls System
9. An outline specification for any work required or necessary but not covered by the documents provided by the Employer.
10. A statement as to whether or not, in each case, products specified by proprietary name in the Employer's Requirements (either, stated as specifically required or, specified as examples meeting the requirements) are included in the Contractor's Proposals and if not the alternative offered.
11. The proprietary names of all significant products to be included in the Works but not covered by the above items.
12. Any other written or drawn information the Contractor considers necessary to submit to further explain his Proposals.
13. Identification of any ambiguities, inconsistencies or errors found by the Contractor in the documents provided by the Employer and a statement of how these issues have been dealt with.
14. Identification of any items or work not included in the tender sum but which are necessary for the completion of the Project.

1.3.16 Installation Liaison and Co-ordination

The Mechanical Contractor shall co-operate with the Main Contractor and all other work package Contractors to agree the detailed arrangement and sequence of erection of the installations before the work is commenced. Any work associated with the mechanical installation package which has to be re-done due to negligence, will be the responsibility of the Mechanical Sub-Contractor.

Where large items of plant and equipment or long lengths of pipework/tube/conduit etc., are to be installed, the Mechanical Contractor shall advise the Main Contractor in good time for access to be provided before construction work limits access.

Particular care shall be taken to obtain uniform and tidy arrangements of pipework, ductwork and cable containment systems and ceiling mounted equipment.

The Mechanical Contractor, in conjunction with the Main Contractor and all other work package contractors shall co-ordinate all mechanical, electrical, specialist, environmental and public health services. The Mechanical Contractor shall ensure that all services are co-ordinated and where necessary, in heavily services areas, produce co-ordinated service drawings/sketches/details allocating space for the various services.

The details etc. shall be submitted to the Project Manager for acceptance in principle after which copies shall be provided to all the interested parties.

The Project Manager's acceptance in principle shall not relieve the Mechanical Contractor of his overall responsibility for ensuring full co-ordination of his/her services. The Mechanical Contractor shall attend regular co-ordination meetings (at least, but not limited to, weekly intervals) for the preparation of drawings and the installation of the works with other related trades. These meetings are to be chaired by the Project Manager.

The Mechanical Contractor shall be responsible for co-ordination of the work of all his Sub-Contractors including full liaison with the Main Contractor to ensure all his Sub Contractors are fully co-ordinated with the Mechanical Installations.

1.3.17 Testing and Commissioning of Engineering Services

A period of time shall be allowed in the overall construction period for the testing and commissioning of engineering services.

Indicative details of the testing, setting to work, commissioning and performance testing will be as set out in the relevant sections of this specification.

Static testing will generally be carried out by the Mechanical Contractor and witnessed by the Building Services Engineer or his representative at an early stage during the course of the construction. Details of the tests are to be forwarded to the Project Manager for acceptance prior to the times at which the tests are programmed to be carried out.

All dynamic testing and commissioning data shall be forwarded to the Commissioning Manager without undue delay, highlighting any areas where design criteria have not been achieved.

Once the installation is complete, the Mechanical Contractor shall employ a Commissioning Contractor to set the systems to work and generally commission the systems using the Mechanical Sub-Contractors design data where applicable.

Further to the full commissioning of the systems and confirmation that they are to the Mechanical Contractors Design Data, the Mechanical Contractor shall draw up a structured testing and commissioning programme, which shall include dates and times and items of services to be witnessed by the Building Services Engineer. The programme shall be distributed to the Project Manager and sent on to the Building Services Engineer for comment, the Mechanical Contractor shall allow at least one week for comments.

The Building Services Engineer requires all commissioning & testing certification with results showing that the systems have passed to the Mechanical Contractors design, only then; and with the agreement to the programme of witnessing will the Building Services Engineer attend site to witness a percentage of the commissioning results. The Mechanical Contractor shall allow for their Commissioning Engineers being in attendance and demonstrating & verifying the results to the Building Services Engineer, to ascertain that the various elements of each system are in full working order and meet to the design criteria.

The Mechanical Contractor shall allow for his Commissioning Engineer to demonstrate to the Employer that the design intent of the systems has been achieved.

If requested for the BREEAM Assessment, the Mechanical Contractor shall allow for the following:-

- a) Testing of all building services under full load conditions, i.e. heating equipment in mid-winter, cooling/ventilation equipment in mid-summer, and part load conditions (spring/autumn)
- b) Testing shall be required to be carried out during periods of extreme (high or low) occupancy.
- c) Interviews with building occupants (where they are affected by the complex services) to identify problems or concerns regarding the effectiveness of the systems.
- d) Re-commissioning of systems (following any work needed to serve revised loads), and incorporating any revisions in operating procedures in to the O&M Manuals.

In addition to all of the above refer also to the requirements for the “chartered design engineers” who will also be required to actively attend and witness all commissioning including all sub phases.

The commissioning shall follow the “NHS standard 3 protocols” as follows: -

- a) Main contractor to coordinate all commissioning including his full sub contract supply chain involvement. Commissioning subcontract specialist to be fully involved with the same.
- b) Main contractors “Chartered design engineers” to attend site when contractor states commissioning is completed and to fully witness check 100% of the same including all results and as drawn information.
- c) Only when “chartered design engineers” have fully satisfied themselves that commissioning is completed will clients team attend and random check results. If random checks indicate problems then whole process is to be repeated until trouble free.

It should be noted that the site Maintenance Department is to be allowed full access during all above stages to allow full familiarisation of the installed systems before being handed back to the client.

1.4 SYSTEMS DESIGN CRITERIA

1.4.1 General Design Criteria

The following section indicates in general terms the design conditions required throughout the project and shall be read in conjunction with the detailed information (such as drawings and room data sheets) provided elsewhere.

1.4.2 Heating Systems

The criteria set out for the design and sizing of the heating system shall: -

1. Maintain design conditions within the spaces served.
2. Provide an acceptable and comfortable environment.
3. Minimise energy waste.
4. Maximise efficiency.
5. Ensure simple / practical operation and maintenance.

In calculating the heat loss from the building fabric the following thermal performance criteria shall be used (Note - The contractor should seek clarification of the exact proposed fabric criteria, the figures shown below are provisional):-

U-value / Thermal Performance Criteria	
Description	Value
Wall	As detailed by the Architect
Window	As detailed by the Architect
Winter Internal Temperature	Minimum 21°C
Winter External Temperature	-10°C
Winter Infiltration Rate	As detailed by the Architect

Peak heating loads shall be calculated for each space and an appropriate emitter selected taking account of margins for flexibility.

Infiltration

Internal heating loads shall take account of any infiltration through the building fabric, including fresh air loads. The present Winter Infiltration rate for use in heat loss calculations shall be taken as 1.0 air changes per.

Heating Systems Sizing Criteria and Performance Requirements

The method of heating to the new facility is to be determined by the mechanical contractor; however it is expected to be by the new AC system.

For LPHW systems the heating pipework installations shall be designed to the recommendations laid down in the CIBSE guide to current practice and in particular the following: -

- Heating system maximum pipework velocities shall be as detailed in the CIBSE guide dependent upon pipe size.
- Heating system maximum pipework pressure drop shall be limited to 250 Pa/m, in the majority of cases limits shall be less than this to suite variable flow pipework design (typically 100 - 150 Pa/m), valve authority, maximum pressure delivery valves can operate against etc. In low loss headers pipework pressure drop shall be limited to 5 - 10 Pa/m.
- Pipework shall be fully sized and proportioned to take account of system pipework heat losses.

Pipework distribution shall be designed to supply the necessary flow rate for the operating temperatures plus allowance for distribution system losses.

A margin is to be added for early morning boost and any redundancy / expansion specified. Margins etc. shall be calculated in accordance with CIBSE guides.

The following shall be adopted for the various systems design unless advised otherwise in the particular sections of this specification:-

LPHW Heating Design	
Description	Condition
LPHW Operating Temperatures:-	80°C flow, 60°C return (Contractor to confirm on-site before final calculations undertaken)
Boosted Output for required Pre-Heat period	As thermal modelling software (HevaComp, IES, etc.) heat loss calculation and dependent upon occupancy
Pipework distribution losses	Maximum +5%

1.4.3 Domestic Hot and Cold Water Systems

Domestic hot and cold water systems shall be designed to achieve a number of criteria including:-

1. Maintain discharge flow rate and temperature at all outlets under anticipated minimum and maximum demand.
2. Ensure that conditions throughout the system prevent the risk of legionella or other bacterial growth occurring.
3. Minimise energy waste.
4. Maximise efficiency.
5. Ensure simple / practical operation and maintenance.

The following conditions shall be adopted for the various systems design unless advised otherwise in the particular sections of this specification:-

Domestic Hot Water Systems Operating / Sizing Conditions

Description	Condition
DHW flow	60°C
Minimum DHW Return	55°C
Maximum outlet temp	See Table 4, HTM 04-01 Part A
Minimum pressure at outlets	0.5 Bar (or sanitary ware manufacturers minimum requirement whichever is greater)
Pressure available from utilities mains	1.0 Bar (unless guaranteed to be higher by utility company)
Flow rates	BS EN 806 loading units to determine flow rate, CIBSE guide to determine pipe size.
Maximum pipework velocities.	As detailed in CIBSE guide dependent upon pipe size.
Pipework pressure drop. (Flow)	Calculated according to the available head on the system and as required to give correct flow at terminal outlets.
Pipework pressure drop. (Return)	Maximum 200 Pa/m

Domestic Cold Water Systems Operating / Sizing Conditions

Description	Condition
Cold water Storage	Not required
Cold Water Storage Capacity	Not required
Maximum rise from building inlet to outlet	4°C
Minimum pressure at outlets	0.5 Bar (or sanitary ware manufacturers minimum requirement whichever is greater)
Pressure available from utilities main	1.0 Bar (unless guaranteed to be higher by utility company)
Flow rates	BS EN 806 loading units to determine flow rate, CIBSE guide to determine pipe size.
Maximum pipework velocities.	As detailed in CIBSE guide dependent upon pipe size.
Pipework pressure drop.	Calculated according to the available head on the system and as required to give correct flow at terminal outlets.

The hot and cold water services installations shall be designed to the recommendations laid down in the CIBSE guide to current practice and the following parameters: -

- Water to drinking points shall be fed direct from the utility mains or via fully potable break tank.

- Booster sets, where used, shall incorporate measures to prevent excessive surge / velocity pressures when re-starting after a fault condition / mains failure including anti-surge valves, anti-vac valves etc.
- Back flow and back pressure prevention shall comply with current water regulations based on the fluid category, please note that RPZ valves (unless called for specifically by the Local Water Authority) should be avoided wherever possible, particularly if they will be seldom used such as quick fill connections.
- Outlets to be provided with means of adjusting pressure to prevent splash over or overflow of sanitary ware.

Water Conservation

Water conservation is to be employed to meet the requirements set down in the NRIA including flow restrictors, dual flush low capacity WC's and percussion taps (WC's and percussion taps supplied by main contractor). A calculation shall be provided based on anticipated consumption with and without the water saving devices to show the annual saving in water consumption.

Legionella

The systems shall be designed specifically in accordance with statutory and recommended and recognised guidance for the control of legionella.

Recommendations as given by the L8 Regulations – The Control of Legionella Bacteria in water Systems, shall be strictly adhered to and shall be applicable to this project. In this regard the following shall be noted:-

- Hot water dead legs shall be limited to lengths noted in previous tables.
- Cold water dead legs shall be limited to 500mm on infrequently used outlets (i.e. pressurisation units, outdoor taps etc.). Any future connections shall be arranged such that no dead leg is presented in the short term.
- Cold water storage shall be arranged such that storage temperatures do not exceed 20°C by use of tank positioning, insulation, plant room ventilation and adjustable volume to allow turnover to be accurately matched to actual demand.

1.4.4 Ventilation Systems

The building shall be ventilated by mechanical solutions as indicated elsewhere in this specification.

Air change rates in all areas shall be designed to comply with the minimum standards given in the current Building Regulations, in accordance with the current CIBSE, HBN and HTM guidance documents and in line with the room data sheets. The air change rates shall also achieve the performance criteria requirements detailed on the room data sheets. The Mechanical Contractor shall provide within his/her design for the most onerous requirement.

Extract systems shall exhaust directly to outside i.e. dirty systems not to be re-circulating, and they shall provide extract rates in accordance with the current CIBSE guide (whichever is the most onerous).

Where summertime calculations demonstrate that natural ventilation alone cannot meet the summer overheating criteria mechanical ventilation systems shall be incorporated as necessary to ensure that the summertime conditions are achieved.

Appropriate ventilation systems shall be selected to meet the design criteria stated previously and to suite the building construction methods adopted.

Ventilation rates for photocopiers, kitchenettes and tea prep areas shall be designed to meet Building Regulation and CIBSE requirements as a minimum, see Design Criteria for further information.

Ductwork Distribution

Ductwork is to be distributed within the facility where there will be a suspended ceiling provided. Ventilation is to be mainly via ceiling recessed supply diffusers and extract grilles.

Ductwork Sizing

The ductwork systems, for ventilation or other, shall be designed in accordance with the recommendations laid down in the CIBSE guide to current practice and the following parameters: -

- General supply and extract velocities within ductwork systems shall be limited to 5 m/s in plant rooms, a maximum of 4 m/s in main ducts, 3 m/s in all branch ducts and 2.5 metres per second to final terminations where low noise criteria is required.
- The maximum pressure drop per metre run of ductwork shall be limited to 0.8 Pa/m run on supply and extract systems.
- Total pressure drop for a system shall be designed such that Part L limiting (W/l/s) specific fan powers can be achieved, external static pressures shall be no more than 450 Pa for supply air and 350 Pa for return air.
- Velocities shall be limited as required to ensure noise regeneration does not exceed the noise levels given. Terminals shall be located so as not to cause a nuisance due to drafts and the like.
- Ductwork shall be sized on a combination of velocity and constant pressure drop basis throughout all systems with balancing dampers provided as required. Any individual damper shall not be required to reduce system pressure by more than 30 Pa when regulating flow, unless adequate regeneration attenuation is provided downstream.

1.4.5 Internal Design Conditions

The mechanical and passive services installations shall be designed to provide the specified internal environmental parameters given on the room data sheets or as

required within the HTM and HBNs. This laboratory should be designed with 10 air changes per hour..

1.4.6 External Ambient Conditions

The mechanical services installations shall be designed to provide the specified internal environmental parameters when the building is subject to the following external conditions: -

External Ambient Design Standards	
Description	Condition
Winter external (design condition for plant selection)	-10°C db : 10°C wb
Summer external (design condition for plant selection)	30°C db : 21°C wb
Summer external (design condition for selection of condensers / chillers)	35°C db, 21°C wb
Maximum noise level (With all plant operating at peak output, 3m from building perimeter)	5 dB below current ambient level, NR30 or Building Control Requirements, or Planning Conditions, whichever is the most onerous.
Summertime temperature.	CIBSE Design Summer Year, nearest geographical location of similar conditions available.

1.4.7 O & M Manuals; Record Drawings; Log Book and User Guide

At least one month prior to Practical Completion of the Works or part of the Work (i.e. immediately prior to the commissioning and performance test period) the Mechanical Contractor shall have prepared complete maintenance and operating instructions for the systems as detailed in Section Two and other sections of the Specification. These shall be approved by the Engineer after which the Mechanical Contractor shall supply to the Engineer four sets of the manuals bound in covers capable of withstanding continual heavy use.

Electronic versions of the manuals shall be provided as detailed above.

Additionally, a Building Log Book shall be provided for the project in accordance with the requirements of CIBSE TM31.

1.4.8 Seasonal Commissioning

The contractor shall include for three further site visits following the completion of the project to carry out seasonal commissioning of all of the newly installed and the existing modified services over an 18 month period.

1.4.9 Equipment

All equipment shall have a minimum parts availability of 10 years.

1.5 REMOVAL/MODIFICATION OF EXISTING SERVICES

1.5.1 General

This project is to provide a full life cycle of the existing Fracture Clinic at The Manchester Royal Infirmary, therefore the contractor shall include for the removal of all existing mechanical services serving this part of the hospital.

The Contractor shall disconnect and remove all redundant Mechanical services including redundant fixings, insulation, controls etc. All items not required by the Client or Engineer shall be removed from site. Existing services shall be modified to suit the new layouts as detailed on the drawings and to the specification requirements. The tenderer should visit the site to assess the extent of removals, as no claim on the grounds of want of knowledge in such respect will be accepted.

Water services shall be cut back and all redundant tees within remaining live mains shall be removed and replaced with through connectors, **no dead-legs are to remain on site**. Isolation, draining and refilling of existing for this shall be out of hours.

For the period of demolition and during any other dust generating activity all grilles and/or open ducts shall be sealed to prevent dust entering the rest of the building.

Where insulation to existing services is damaged or unfinished due to removals and or modification or due to general damage on site, the insulation shall be made good to the existing standard by the Contractor at no cost to the Client. Where, on removal of ceilings, insulation on services that are to be retained is damaged, this shall be reported immediately to the Engineer for instruction. A full schedule of any damaged insulation on services that are to be retained shall be forwarded to the Engineer immediately on removal of ceilings / duct covers.

Any insulation not on this schedule, that is subsequently found to be damaged, shall be repaired as part of the Contract at no cost to the Client.

The Contractor is reminded again that certain procedures, programming and access to occupied areas will have to be agreed with The Trust.

Where possible drawings indicating 'as-existing' services have been included within the tender documentation, however these may not include all services and may not be accurate. The client has been unable to provide 'as-built' information for this area so the contractor shall include for undertaking their own surveys of the existing installation at the beginning of the contract. Tenderers shall visit site to assess the extent of services to be removed. No claim will be allowed for want of knowledge of existing services.

1.6 BUILDERS WORK

1.6.1 Scope of Works

The Contractor shall include for all builders work required throughout the duration of the contract in respect to the removal of existing and installation of new mechanical services. This shall include but not be limited to the following:

- Access and site set up
- Scaffolding and lifting equipment
- Removals, skips etc.
- Making good holes following removal of redundant services to walls, floors, roofs, ceilings, boxings, etc.
- Drilling of holes for pipework, ductwork, drainage, and fixing brackets etc.
- Removal/replacement of false ceilings to access mechanical services

1.6.2 Screening of the Works

The works are to be carried out within an area of the building, which is still occupied. The contractor should make allowance for the installation of screening between the areas of work and adjacent areas.

1.6.3 Protections of Existing Finishes

The Contractor is to protect against damage to all existing walls, floor and ceiling finishes in any area where work is to be carried out.

1.7 ABOVE GROUND DRAINAGE

1.7.1 General

The Contractor shall design, supply, and install new above ground drainage as detailed on the drawings and in this specification.

Any works carried out outside the area of the contract works shall be carried out outside normal working hours and with guidance from the hospital staff. All existing drains should be treated as contaminated waste and should be disposed of as contaminated waste. The contractor should seek clarification from the Trust that the drains have been tested and are provided with a clearance certificate.

All above ground drainage pipework, vents and fitting shall be manufactured from PVCu and muPVC and shall fully conform to the standards BS 4514 and BS 5255.

Traps to sanitary appliances shall be manufactured from polypropylene and conform to BS 3943 where appropriate.

The system shall be designed and installed in accordance with BS EN 12056-1:2000 and the relevant sections of the building regulations.

Where pipes are cut on site, ends shall be cut clean and square with burrs removed. Spigot end of cut pipework shall be chamfered prior to insertion into a socket.

All pipes and fittings shall be jointed by means of either push fit 'o' ring sockets with seals conforming to BS 2494 or by solvent welding in accordance with the manufacturer's instructions.

Connection to small diameter waste and ventilating pipework or other materials shall be made using mechanical 'compression-fit' boss pipes or push-fit manifold or blank ends as necessary.

Pipework shall be supported true to line by methods strictly in accordance with manufacturer's recommendations.

Above ground drainage pipework to be installed using manufacturer's recommended installation guidelines together with BS EN 12056-1 and relevant building regulations.

All above ground pipework shall be suitably restrained/bracketed in order to withstand the weight of pipework when full of waste.

1.7.2 Description of Public Health Works

This Specification provides the outline details for the Contractor to enable him to supply, deliver, install, test, commissioning and handover the complete public health services for the proposed development.

The Contractor shall allow for within his tender return all necessary main soil / waste and ventilation stacks together with branch pipework and traps required for the execution of the Works. The whole installation shall be testing and commissioning in accordance with the BSEN 12056 and Part H1 of the Building Regulations.

Detailed below are descriptions of the Public Health Services to be installed as part of the Contractor's Works:

1.7.3 Soil & Waste Installations

The Contractor shall supply and fit above ground drainage services to serve sanitary ware and equipment as indicated on the drawings and as described herein.

The Contractor shall include for modifying the above ground soil and waste pipework installation including the following:

- a. connection into existing above ground drainage system
- b. the supply and fixing of all sanitary ware (as indicated on the architects drawings and his sanitary fitting schedule)
- c. the installation of overflows from all items of equipment requiring an overflow including WCs
- d. final testing and certification upon completion of the works

The waste pipe installation shall be high temperature PVC waste system in accordance with the Standard Sections. The installation shall be in accordance with BS EN 12056, Part H1 of the Building Regulations and to the requirements of the Water Supply (Water Fittings) Regulations 1999. All pipework shall be arranged neatly on organised routes and shall be co-ordinated with the structure and all other services.

1.7.4 Design Parameters

The public health services have been design in accordance with the following criteria and the standards described elsewhere within this Specification.

The above ground soil and waste installation have been designed to meet the following minimum requirements and comply with BSEN 12056 and Part H1 of the Building Regulations:

- a. Sanitary appliances drain quickly, quietly and completely at all times without nuisance or risk to health
- b. Discharge is conveyed without in a safe and efficient manner without cross-flow, back-fall, leakage or blockage
- c. Pressure fluctuations within the pipework system does not vary by more than ± 38 mm water gauge and that traps retain a water seal of not less than 25mm
- d. The system can be adequately tested, cleaned and maintained
- e. Suitable fire stopping is provide to all combustible pipework passing through walls and floors

Provision has been made for access fittings and rodding eyes, as necessary, in convenient locations to permit adequate cleaning and testing.

1.7.5 Soil & Waste Pipework and Fittings

All materials shall comply with the requirements of the latest editions of the appropriate British Standard Specifications, including any amendments current at the commencement of the Contract. Pipework and fittings shall be suitable for the range of temperatures of conveyed fluids to be handled.

Soil pipe connections to WC pan spigots, or similar soil appliance outlet, shall comprise "Multi-kwik" or similar flexible connector jointed into plain end pipe.

Main soil and waste stack pipework shall be lightweight cast iron with socket less joints but mechanical couplings complete with neoprene gaskets and electrical continuity clips all conforming BS EN 877 and the British Board of Agreement Certificate.

Soil and waste branch pipes shall be PVC-u complying with the relevant requirements of BS 5255, BS 4514 and BS EN 1329 - Part 1. Solvent welded joints will be permitted but adequate provision shall be made to cater for thermal expansion and dismantling of pipework by use of slip joints with rubber gaskets.

All pipework and fittings shall be installed in full accordance with the manufacturer's requirements and recommendations.

1.7.6 Soil & Waste Installation Workmanship

All pipes, fittings and components shall be checked for soundness and freedom from defects and damage prior to installation.

All stacks shall be installed truly vertical, and horizontal pipework shall be true in alignment and to uniform gradient. All stacks shall be supported by at least one pipe support bracket in a manner to support the vertical load and in any instance, the distance between pipe supports shall not exceed the distances specified in the manufacturer's requirements, BSEN 12056 Part 2 and Part H1 of the Building Regulations.

Pipe supports shall be fixed as the pipework installation proceeds. Improperly supported pipework shall not be left for "later fixing" and shall either be attended to immediately or taken down.

All suspended pipework shall be positioned as close to the slab soffit as practicable.

Provision shall be made in the fixing of branch pipes to the main vertical stack to prevent shearing or deformation due to vertical movement of the main pipe.

All bends on soil stacks shall be long radius. All changes of direction and branch connections on suspended soil and waste pipe runs shall be made with 135° bends and branches, except where this is not practicable, in which case the fittings shall have the greatest angle possible below 135°.

All pipework joints shall be airtight and watertight.

All pipework shall be securely supported with substantial brackets. Hangers and accessories shall be galvanised or zinc plated or other equal and approved rust-proof finish.

Care shall be taken to ensure that the pipe axis is parallel with the axis of the pipe ring or bracket and that drop rod supports are vertical. All supports shall be in alignment and shall not impose side strain on the pipework and shall provide a uniform pipe gradient.

Additional supports shall be provided at branch connections and changes of direction on suspended pipework providing a stable and secure pipework system capable of being rodded through without detriment to the system.

Branch connections shall be supported independently and not used to help in the support of its parent main.

All pipework and fittings shall be installed in strict accordance with the manufacturer's recommendations and the requirements of the relevant British Standards

1.7.7 PVC-mu Waste Pipes

The Contractor shall supply, deliver and install PVC-mu pipework and fittings for use as branch waste pipework from sanitary fittings as indicated on the Contract Drawings.

All waste pipes and fittings shall be solvent welded joints except where seal ring joints are required for thermal movement.

All pipes and fittings shall comply in all respects with the requirements of BSEN 1329 and shall, where appropriate, bear the British Standard Kitemark.

Plastic pipes expand and contract with changes in temperature. It is therefore essential that expansion joints shall be provided for the relief of all thermal movement. Where a pipe is made good when passing through a floor or wall, it shall be treated as a fixed point when arranging positions of expansion joints. An expansion joint must be fitted between any two fixed points one metre or more apart as follows:

Manufacturer: Geberit Terrain Limited or equal & approved

1.7.8 Traps

The Contractor shall provide all necessary traps to enable the safe and effective operation of the above ground soil and waste installation as generally indicated on the Contract Drawings.

Tubular traps shall be polypropylene deep seal two piece pattern complying with the relevant requirements of BS 3943 colour white, with universal compression outlet connection.

Plastic bottle traps shall be polypropylene deep seal with adjustable sliding inlet tube, removable base, and universal compression outlet connection. The use of anti-siphon type traps shall be acceptable.

Manufacturer: Geberit Terrain Limited or equal & approved

1.7.9 Access to Pipes

The Contractor shall provide access doors, rodding eyes and cleaning eyes at all changes of direction and at the head of horizontal pipe runs; access doors / panels are not necessarily shown on the Contract Drawings.

All soil and waste pipes shall be provided with a large access door at the base of each pipe immediately before entry to the below ground drainage system. Where branch connections occur to the stacks at low level, access doors shall be installed immediately above the highest connection at that level.

All access requirements contained within BSEN 12056 and Part H1 of the Building Regulations shall be met in full.

1.7.10 Testing

Testing of the installation shall be carried out as specified, having first checked that all sections of the installations are securely fixed, free from obstructions and debris, and that all traps are filled with clean water. All tests shall be recorded and a copy handed to the CA.

The testing and commissioning shall be carried out in accordance with the requirements of BSEN 12056 and Part H1 of the Building Regulations.

1.7.11 Schedule of Manufacturers & Suppliers

The Contractor shall in all instances comply with the manufacturers specified within this document for the compilation of his tender return. Should however, he wish to offer alternative suppliers the Contractor shall clearly identify his alternatives together with any cost savings offered on a separate sheet.

Approval of such alternatives will be at the discretion of the CA.

Where the CA is not familiar with, or at their request, the Contractor shall supply samples of the fittings and / or the associated technical literature. A statement from the manufacturer or supplier on the anticipated life expectancy under normal use will also be required.

As previously indicated, the CA has the opportunity to amend this Specification to include changes that he believes may improve the design, form part of his corporate standards, reduce costs or to take advantage of any manufacture supply chain agreement.

Any variation in cost will be assessed between the CA, PQS, and the Contractor.

1.8 DOMESTIC WATER SERVICES

1.8.1 General

The Contractor shall design, supply, and install new domestic water services as detailed on the drawings and in this Specification. This involves the replacement of the existing wash hand basin.

Hot and cold services shall be treated as potable.

The contractor shall take water samples throughout the contract area on both the hot and cold water systems before the contract works commence. Water samples are to be tested for TVC, Legionella, pseudomonas, e coli, etc in the same manner as those test which are to be taken at the end of the works and before handover. The contractor shall also take temperature tests at all outlets before works commence and provide these to the design team.

The pre-contract tests are to highlight any existing water quality issues before the contractor commences work on the existing systems. Should the contractor not carry out the pre-contract tests, and a subsequent problem with water quality is found at the hand over stage, then this deficiency in water quality will be deemed to be the responsibility of the contractor who shall undertake all necessary works and procedures to ensure the water quality is left in a suitable condition at handover.

All existing redundant water services shall be cut back and removed, with all redundant tees within remaining live mains being removed and replaced with through connectors, **no dead-legs are to remain on site**. Isolation, draining and refilling of existing for this shall be out of hours.

The exact location of all the existing mains and distribution pipework is unknown. The contractor shall undertake their own surveys of the contract works areas in order to establish the full extent of the existing installations. As-built information is not available of the existing installations.

The contractor shall include within their tender price for undertaking the surveys of the existing installations and producing marked-up drawings of these services. The contractor should visit site during the tender period to ascertain the extent of the existing installation and strip out works. No claim on the grounds of a lack of existing information will be accepted; it shall be deemed that the contractor has included for all strip out works within their tender return.

1.8.2 Pipework, Valves and Fittings

Pipework, valves and fittings shall be in accordance with the Standard Sections. Pipework shall generally be light gauge copper with capillary fittings.

All materials and installations shall also comply with Water By-Laws.

Isolating valves/stop cocks shall be fitted in ceilings at main branches, prior to individual pipe drops and at each outlet. Isolating valves on hot water returns shall be of the lockshield regulating type with set point memory.

Valves shall be quarter turn lever action full bore ball valve type complete with extended spindles for insulated pipework. Final isolating valves shall be quarter turn lever action ball type.

Connections to existing shall be as detailed in removals/modifications.

Cold water pipework shall be run 150 mm clear of heating/hot water pipework where possible.

No flexible connections shall be used.

No hemp shall be used.

1.8.3 Insulation

All new water services pipework, valves and fittings in ducts, ceiling voids, IPS panelling, boxing, within plantrooms, and external shall be insulated using pre-formed mineral wool as detailed in the Standard Sections.

Cold water pipework (10°C) valves and fittings shall be insulated against condensation with a continuous vapour barrier and Class O reinforced foil backed finish.

Hot water pipework (65°C), valves fittings etc. shall be insulated to conserve energy with a Class O reinforced foil backed finish.

Exposed pipework in occupied rooms, if any, shall be uninsulated. All external pipework shall be insulated with a suitable weather proof material.

The contractor is to include for insulating the existing cold water service pipework where it is to be reused and found to be uninsulated.

Cold water pipework insulation shall be continuous through pipe sleeves and brackets.

1.8.4 Terminations

The Contractor shall carry out all final connections to sanitaryware, water boilers, bed pan washers, sluice, macerators, washer disinfectors, etc supplied under the Contract as Group 1, 2 or 3 items.

Connections to all sinks, WHB's, showers, urinals and WC's are to be fixed piping. Flexible connections are not allowed.

The Contractor shall refer to the Architects Sanitary Schedule for further details.

1.8.5 Fire Stopping

The Contractor shall note all fire walls indicated on drawings continue above ceiling to the slab over. The Contractor shall fire stop all pipework new and existing between sleeves and pipes.

The Contractor shall remind the Building Contractor that he needs to make good around sleeves to maintain the integrity of the walls.

1.8.6 Valve Labels and Identification

Pipework shall be identified as the Standard Sections. Valve labels shall be fitted as the Standard Sections, to isolate branch distribution and each individual outlet.

Local Isolation up to 1 1/2" – Quarter turn (Stem safe) manufactured by Horne.

1.8.7 Disinfection

Services shall be disinfected as the Standard Sections. The Contractor shall note that existing pipework also serves other areas and shall take all precautions to ensure disinfecting agents etc., do not migrate to other drains.

A method statement will be required to be submitted by the Contractor for comment two weeks prior to the intended disinfection. Disinfection shall be carried out immediately prior to handover. Throughout the duration of the works and following the chlorination and testing of the water installations it is the contractor's responsibility to undertake daily flushing of water outlets and keep a record of this flushing. Records of this flushing regime will be provided at handover.

1.8.8 Thermostatic Balancing Valves

The contractor shall supply and install thermostatic balancing valves on the hot water return branch connections as indicated on the drawings. Each valve shall consist of DZR – Brass body with adjustable thermostatic element pre-set to 57°C by the manufacturer. Valves shall be as manufactured by Hattersley, Crane or equal and approved.

1.8.9 Fixing

Water services shall be supported as detailed in the standard sections.

Cold water service shall have insulated brackets.

1.9 HEATING/COOLING – REFRIGERATION AIR CONDITIONING

1.9.1 General

The Contractor shall provide a new DX Split heating/cooling system as identified on the drawings and schedules of equipment.

The Contractor is reminded that some work is in other areas and that existing services to other areas have to be maintained, as detailed in Other Elements. The Contractor is to allow for out of normal working hours for such work.

1.9.2 Comfort Conditioning

Air conditioning services shall be supplied, installed, set to work and commissioned as per detailed within the Standard Sections. The Contractor shall include for the supply of air conditioning by a specialist supplier and installed by a specialist installer approved by the manufacturer.

Refrigeration units shall be manufactured by Mitsubishi Electric or other equal and approved.

Internal unit power supplies are to be provided by the electrical contractor.

Control wiring shall be run by the Contractor and shall be installed within conduit, within walls. The Contractor is to supply and install the required conduit.

All other field wiring, controls, equipment, refrigerant pipework, condensate pipework, and condensate pumps (if required), shall be supplied, installed and commissioned by the specialist AC contractor/installer. The Contractor shall include for all the necessary containment.

Any works to existing and new equipment containing F-Gas refrigerants is to be carried out by a competent HVAC registered contractor fully accredited with a Stationary Equipment Qualification F-Gas Company Certificate (Full Certificate). One such contractor, with experience and knowledge of the site, is as follows:

1.9.3 Electric Wiring Installation

The Contractor shall carry out all interconnecting control wiring and containment between the indoor units, outdoor units BC controllers, energy saving controllers and heat exchange ventilation units as detailed on the drawings.

The separate Electrical Specification includes single phase power supplies to all indoor units.

1.9.4 Controls

Within each room/area internal A/C units shall be provided with a hard wired controller. Control wiring shall be run by the Contractor and shall be installed within galvanised conduit, within walls. The Contractor is to supply and install the required conduit.

All other field wiring, controls, equipment, refrigerant pipework, condensate pipework, and condensate pumps (if required), shall be supplied, installed and

commissioned by the specialist AC contractor/installer. The Contractor shall include for all the necessary containment.

The contractor shall supply and install a new centralised controller Ref: AE-200 complete with an AE-200E BACnet Pin. This will allow the integration of the AC system into the site wide BMS. The contractor shall include for the BMS Specialist to link this AC system into the BMS.

1.9.5 Identification

The whole of the works shall be identified as the Standard Sections.

1.9.6 Drainage

The Contractor shall run condense drainage to outside drain points, via borosilicate glass traps, from all indoor units.

Drainage pipework shall be to the Standard Specification.

1.9.7 Testing, Settings to Work and Commissioning

The whole of the works shall be cleaned, tested, commissioned, set to work and demonstrated once to the Engineer and secondly user, all as the Standard Sections.

1.10 VENTILATION SERVICES

1.10.1 General

The Contractor shall design, supply and install ventilation services as detailed on the drawings and in this specification. This briefly involves the provision of 1 No. ceiling void mounted heat recovery unit positioned above the laboratory. The ventilation requirements will be sized to provide a minimum of 10 air changes per hour. The heat recovery unit shall be provided with filtration and electric heater battery.

New ductwork shall be provided from the unit complete with all associated grilles and fittings, dampers etc.

Surveys of existing installations have been undertaken however some areas are restricted and the full extent of the existing installations has had to have been assumed. The contractor shall note that they should include for additional surveys of the existing installations once full access to ceiling/roof voids is available to them. They are to complete survey drawings for issue to the design team and highlight any anomalies on the proposed design.

All existing redundant ventilation services are to be removed.

1.10.2 Ductwork, Fittings and Supports

Ductwork, fittings and supports shall be to the standards and requirements of the Standard Sections. All ductwork shall be protected to prevent the ingress of debris during transportation and installation. If it is found that the ductwork has not been suitably protected then the contractor shall carry out a full clean of the ductwork systems before the facility becomes operational. Any costs incurred for this clean shall be paid for by the contractor.

All support and fixing details are to be issued for approval by the relevant structural engineer.

Ductwork shall be galvanised mild steel to Table 1 of DW144 Part Two, low pressure with Class A air leakage. Final connection to grilles may be in flexible ductwork up to a maximum length of 600mm.

Supports, which shall generally be as the Standard Sections and as noted in Element 01, shall have flexible neoprene inserts to reduce the passage of vibration.

1.10.3 Access Panels

Access panels are not detailed on the tender drawings but should form part of the contractor's final installation drawings and installation. These shall be fitted adjacent to all fire dampers, control dampers, bends, filter, both sides of heating / cooling coils, fans, etc. and to meet the requirements of TR19 Guide to Good Practice – Internal Cleanliness of Ventilation Systems

Additional access panels shall be fitted such that the entire ductwork system can be cleaned.

Ductwork and access panel positions shall be fitted such that access can be gained to access panels.

Access panels shall be to the standard specification.

1.10.4 Test Holes and Instruments

These shall be fitted to allow the air flow in ductwork to be measured and the system balanced. Tests holes shall be 13mm to DW144 not 25mm as the standard specification.

1.10.5 Insulation

All new supply ductwork and flanges, which will generally supply air at 16-28°C, and all extract ductwork from ventilation systems incorporating heat exchange technology, shall be insulated as the Standard Sections. Flexible ducting may be used for final connections to grilles and diffusers, provided it is constructed to meet the fire precautions recommended within BS 8313 and never exceeds 0.6m in length. Flexible ductwork to grilles must be pre-insulated. Insulation to include vapour seal. Plenum boxes to grilles etc. shall also be insulated. Insulation shall be continuous through supports.

External supply and extract ductwork shall be insulated to conserve energy and have a weatherproof finish. External ductwork insulation shall have a birdproof/waterproof finish by Venture Clad (01327 876555) with white finish, 13 ply foil.

1.10.6 Fire Stopping

The Contractor shall note all fire walls indicated on drawings continue above ceiling to the slab over. Smoke/fire dampers are to be as provided by Actionair their smokeshield PTC Mode 6 (240V) smoke damper complete with SFD1 (interface units) for wiring by the Electrical Contractor.

Dampers shall be complete with stainless steel blades out of the air flow and with reset facility on each side, as supplied by Action Air complete with an electrical thermal release device set to operate at 72°C.

Contractor is to include for employing an *Action Air* approved contractor to attend site and commission new dampers.

The Contractor shall liaise with the Building Contractor to ensure walls around fire dampers are made good to maintain the integrity of the walls. Access panels shall be provided on both sides of the dampers.

1.10.7 Identification

All new ductwork shall be identified as detailed in the Standard Sections.

Ductwork serving the isolation suite to be complete with bio-hazard symbols as per stipulated within HBN 4, Supplement 1.

1.10.8 Grilles and Diffusers

The Contractor shall supply and install grilles and diffusers of the size shown in the Schedule of Grilles and Diffusers.

All grilles and diffusers shall have plenums with outlets/inlets to suit the associated ductwork. Plenums and grilles shall be supported from Unistrut fixings and shall have volume control dampers on the plenum inlets.

Grilles and diffusers shall be as supplied by Gilberts or others equal and approved by the design team and client.

1.10.9 External Weather Louvres

The Contractor shall design, supply and install louvres as detailed on the relevant drawings and schedules. These shall be manufactured by Gilberts. The contractor shall request the exact RAL colour before ordering the louvres.

New louvres shall be as supplied by Gilberts c/w insect screen and bird guard. The contractor shall provide adequate access through ceilings and the ductwork in order to be able to clean the louvre, insect screen, and bird guard from inside the building. All louvres shall be provided with a fully insulated plenum to the rear where the ductwork connects to it. Insulation to the rear of louvres will meet the minimum requirements of the enclosed insulation specifications.

Grilles, diffusers and louvres shall be as supplied by Gilberts or others equal and approved by the design team and client.

1.10.11 Heat Exchange Units

The Contractor shall design, supply and install a ceiling void mounted heat recovery ventilation unit as manufactured by Nuaire.

The internal unit shall be provided with:

- PIR control of the unit.
- Nuaire Ecosmart controllers

The Contractor shall design, supply and install the unit, the hard wired controller, and include for all field wiring from the control panel to the unit. Control wiring shall be installed within conduit, within walls. The Contractor is to supply and install the required conduit and all other necessary containment for a complete installation.

The unit shall be controlled via time control, PIR motion sensors and shall be monitored on the BMS.

The Electrical Contractor shall supply and install the power to the unit.

1.10.11 Ductwork Attenuation

Ductwork mounted attenuating equipment shall be installed generally as indicated within this specification.

The equipment shall be designed to reduce the passage of the generated plant noise into the building to a level of NR40 and at 5 metres from the inlet louvre on the atmosphere side, and NR35 on the system side within the building. Air resistance is to be included as part of the entered resistance for the ventilation air handling unit.

Attenuation shall be provided by Nuaire to match the requirements of the new heat recovery unit being installed.

1.10.12 Roof Pro Support System

All roof mounted equipment (ductwork, pipework, etc.) shall be positioned on purpose designed mounts as supplied by Roof Pro:

Roof Pro

Tel No: 01234 843 790 or equal and approved.

The contractor shall design and supply all service support and hanging requirements.

1.10.13 Ductwork Cleanliness

All new ductwork should be stored, installed and protected in order to maintain internal cleanliness throughout the contract and for handover. Therefore, the contractor shall ensure that they protect the ductwork from the ingress of dust and dirt and if required carry out a full internal clean of the new ductwork systems prior to handover. The contractor shall note the following abstract which should be adhered to and will be used as the benchmark for ductwork cleanliness:

Below is an extract from the 'GUIDE TO GOOD PRACTICE Internal cleanliness of ventilation systems (TR19) 2nd Edition | October 2013 Building & Engineering Services Association' - page 13 which should be used to take the subjectivity out of whether or not the duct work systems require to be cleaned.

Protection, delivery and installation standards for maintaining the internal cleanliness of new ductwork prior to commissioning and/or handover.

2.1 With the introduction of BS EN 15780 all interested parties should be made aware that there are now three classifications of system types with regard to internal duct cleanliness. The document gives guidance on the system quality class for each of these types of areas (see table 1 below) and the most applicable should be agreed between the installer/building owner and other interested parties prior to the commencement of installation. This British Standard requires a verifiable cleanliness standard to be achieved prior to handover. Acceptable dusts accumulation levels for new ductwork are shown in table below (table 2).

Cleanliness quality	Acceptable dust	Acceptable dust
9 class	accumulation level	accumulation level
.	Supply, recirculation or	Extract ductwork
3	secondary air	
	ductwork	
ALow	<0.9 g/m ²	<1.8 g/m ²
fMedium	<0.6 g/m ²	<1.8 g/m ²
tHigh	<0.3 g/m ²	<0.9 g/m ²
e		
r		
Medium	Offices, hotels, restaurants, schools, theatres, residential homes, shopping areas, exhibition buildings, sport buildings, general areas in hospitals , general working areas in industries	

The ductwork and other relevant components, surfaces should be visibly clean and capable of meeting the required acceptable post-clean level.

9.4 For most normal duct cleaning work, the preferred method of establishing acceptable post-clean level is to use the preferred vacuum test ('PVT') see Appendix D (based on BS EN 15780) for technical details. The deposit thickness test is not suitable for post clean verification.

9.5 The acceptable post-clean level is <0.3 g/m², using the PVT.

Timing of post-clean verification testing

9.6 It should be noted that post-clean verification testing should take place immediately after cleaning to avoid any possibility of post-clean contamination outside of the control of the cleaning contractor. The client should be given the opportunity to witness testing of ductwork surfaces.

Completion report

9.7 On completion a comprehensive report should be provided. This should clearly state the following information:

- The ventilation system(s) cleaned
- Cleaning methods used
- Verification results
- Pre- and post-clean photographic records
- Any faults identified that could impact future hygiene
- Additional works carried out (if any)
- COSHH data on any chemicals used for cleaning or biocidal treatment
- Recommendations for future testing and cleaning requirements.

Clearly, if a qualified 'objective' assessment can be made that demonstrates that the levels of dust are less than 0.6 g/m² for supply duct work and less than 1.8 g/m² for extract duct work then there would be no need to clean the duct work.

1.11 FUME EXTRACT**1.11.1 General**

The Contractor shall design, supply and install new fume extract ventilation systems as detailed on the drawings and in this specification.

The fume extract systems are briefly described as: -

- The supply and installation of a new fume extract fan and ductwork connected to a new safety cabinet. (Safety Cabinet supplied by others).

1.11.2 Survey

As existing drawings are not available, the Contractor shall include for survey the existing installations when works commences. The contractor is advised to visit site to ascertain the existing installation for removal and connections to existing before submitting a tender.

1.11.3 Ductwork Fittings and Supports

Ductwork and fittings shall be plastic to HVCA DW/154.

Ductwork shall be Polypropylene with tolerances to DIN 7748.

Supports, which shall generally be as the Standard Sections, shall have flexible neoprene inserts to reduce the passage of vibration and shall be stainless steel in Laboratory ceiling voids by such as Gripple.

Plastic Material	Polypropylene	
Environmental Conditions	Internal Min	+ 2°C
	Internal Max	+ 50°C
	External Min	- 10°C
	External Max	+ 50°C
Airflow and Velocity	As designed	
Pressure Drops	To be advised	
Thermal / Acoustic Insulations	None	
Spark Testing	Not required	
Air Leakage Testing	For class C	
Identification	ID labels for each riser and for main duct on roof	
Solvent / Fumes	Duct rises to outlet	
	Drains to all low points	

Protective Finishes**Finishes to protect Polypropylene material from sunlight**

Pressure Classification

i) Ceiling Voids, local fans and connections to main dispersal duct

Class B

ii) Main dispersal duct on roof (100 Ø to 1600Ø)

Class C

Leakage Classification

As table 1

Positive and negative Pressures

2000 / 750
Pa

Colour on Roof

Grey

Colour Where Fitted onto Red Brick "Red"

04C 39

Access Points

Inspection, servicing and for cleaning including adjacent to dampers

Access panel to be hinged where possible and removable in constrained areas

Note: Contractor to propose cleaning method and access openings to suit. Cleaning proposals to conform to HVCA TR17 "Guide to Good Practice, Cleanliness of Ventilation System"

Drainage Points

Provided to all fans and low points c/w vision porthole at low level.

Regulating Dampers

As required to balance the system

Motorised Dampers and Linkages

To close to prevent back draught. Motors to be by controls Specialist

Flexible Joint Connections

On/ off fans

Fire Retardant Finishes

Where required and where ductwork passes through fire compartment walls.

Controls / Sensing Equipment

Pressure sensors see controls section

Special Supports

Ducts to be supported on roof. Fans to be on special mounts (see below)

Main dispersal / fans to be on steelwork (steel work by builder)

	Rising duct on roof to be supported from existing steel ductwork structure and the wall of the plantroom.
	Discharge duct to be supported on high roof, and to give wind bracing and side supports (loads to be advised to Structural Engineer). Contractor designed element.
	Hangers in ceiling voids shall be treated against corrosion
Attachment to Building Structure	As above, weather cravats to holes through roof, building insulation under cravats similar to tender drawings
Ductwork Layout	As per the Tender drawings
Discharge	High velocity to figure 103 HVCA 154 at 16m/s
Special Coating Finish	GRP (external)

1.11.4 Access Panels

All fume extract ductwork systems shall be provided with access panels to aide maintenance, servicing, cleaning, and draining of the ducts.

All required ductwork access panels are not shown on the tender documentation but should be shown on the contractor's ductwork installation and fabrication drawings. However as a minimum the contractor shall provide the following within new fume extract ductwork.

The access panels shall be installed within ductwork every 10m of length and as per stipulated within TR/19 which is summarised below:-

Location of Ventilation Ductwork Access Panel	
Fitting/Device	One/Both Sides
Control dampers	Both Sides
Fire Dampers	Both Side
Attenuators	Both Sides
Mitre Turning Vanes	Both Sides
Change of Direction	One Side
In-line Duct Mounted Fan (or Device)	Both Sides

Access panels shall be of the hinged variety and shall be full air tight when sealed.

Any additional required access panels shall be fitted such that the entire ductwork system can be cleaned.

Ductwork and access panel positions shall be fitted such that access can be gained to access panels.

All access panel requirements shall be indicated on the contractor's installation drawings which shall be issued for approval before work commences on site.

1.11.5 Insulation

Fume extract ductwork shall be un-insulated unless required for fire retardant requirements

1.11.6 Fire Stopping

Fume extract ductwork, shall be run to avoid crossing fire compartments. Any ductwork crossing a fire compartment shall be fire clad and provided with intumescent collar. Collars shall provide a minimum of 2 hours fire resistance and shall be installed to reflect the requirements of the manufacturer's installation instructions. The completed fire stopping shall be provided with a certificate of completeness and correct installation by the contractor.

All ductwork within the riser shall be provided with a fire retardant insulation as provided by Rockwool, their Ductrock Slab or Fire Tube dependent upon the shape of the ductwork. Insulation shall be rated to a minimum of 2 hours fire resistance and shall be installed to fully comply with the manufacturer's installation instructions and requirements. All flanges and support brackets shall be fully wrapped with the fire insulation as detailed by the manufacturer.

The installation of the fire insulation shall be undertaken by a Rockwool approved installer and shall be provided with certificate of correct installation upon completion.

1.11.7 Fans

The Contractor shall supply and install new fume extract fans as indicated on the drawings and equipment schedules. The fan motors shall be IE3 premium efficiency. The fans shall be constructed with fire retardant polypropylene cases and fire retardant polypropylene impellers.

The fans shall be manufactured by Central Fans – Colasit Ltd, Telephone number: 01527517200.

The new fans are to be sited on anti vibration mounts on purpose designed mounts such as Roof Pro (Tel: 01234 843 790) their MSB 18 x 4TP platforms.

1.11.8 Attenuators

The Contractor shall design, supply and install attenuators to fume extract systems to ensure compliance with the acoustic engineer's requirements and the requirements as detailed within this specification.

The attenuators shall be circular pod type UPVC construction to DW 154 and cases fitted with end flanges with threaded inserts.

1.12 AUTOMATIC CONTROLS

1.12.1 General

The Contractor is to design, supply and install controls as indicated on the drawings, in the standard section and as detailed below. The Contractor shall also include for all control and electrical power wiring from control panels to field control devices.

A Sauter Building Energy Management System (BEMS) shall be supplied, configured and commissioned by a Trend Technology Centre (TTC) approved by the Hospital Estates Department.

In completing the works, the specialist shall comply in all aspects with the requirements as defined by Sauter Control Systems relating to the skills of the engineers employed, methods, standards of workmanship and quality.

No other manufacture of system will be acceptable.

The control specialist shall include for the following:

- The complete design, supply, configuration, documentation and commissioning of the HVAC/BEMS, including all hardware, software and supply of all connected sensors, actuators and inverter drives.
- All field wiring from the control panel to all items of equipment to be controlled.
- All power wiring from the control panel to all items of equipment to be controlled.
- Manufacture, test and commission of all control panels.

The system shall comply in all respects with this Specification and with the particular controls specification, drawings and schedules.

1.12.2 Points Schedules

The BEMS tenderer shall provide a points schedule showing each proposed connected point to the system. The points shall be arranged as schedules showing the points allocated on a plant-by-plant basis, the controller specification(s) selected, I/O capacity supplied and the spare I/O available for future use. Any points schedule supplied with this specification shall be considered as supporting information only. The BEMS specialist shall be responsible for ensuring the correct allocation of points require for meeting the performance specification.

1.12.3 System Features Configuration

The control strategy shall be configured as detailed in the Particular Specification. The strategy shall be designed to be energy efficient and to aid operation and maintenance of the plant.

Alarm levels and inhibits to be configured as directed by the engineer. Trend logs shall be set up to record/display all analogue inputs and calculated flows and totals. The BEMS specialist shall implement a password strategy as agreed with the engineer. The password facility shall be set up for the client's engineers at various levels.

Following a mains power failure, the plant at the MCC's shall start in a sequenced manner with time delays incorporated so as to limit the total surge in demand.

1.12.4 Main Plant Controls

Controllers will be supplied from the Trend IQ4 series controllers and sized in accordance with the particular wiring schedules.

The BEMS specialist shall detail the points capacity of the controllers selected and state the spare Input / Output capacity of each controller.

1.12.5 Field Devices

Where possible field devices from the Trend range shall be employed. A schedule of field devices shall be submitted with the tender cross-referenced to the points schedule showing the total number and specification of the device to be supplied, and shall show the manufacturer, model, range, accuracy, flow characteristics, working, operating and static pressure ranges, all as applicable to the transducer or actuator. The BEMS specialist shall be responsible for the correct output and positioning for sensors. Where sensor positions are indicated on drawings, he shall advise any corrections to the engineer at an early stage of the project.

1.12.6 Installation

The BEMS shall be installed complying with all:

- National and local statutory regulations
- Health & Safety at Work Acts
- IEE Regulations (18th Edition)
- Equipment manufacturers instructions
- Regulations and conditions of BT, and utilities companies

All extra-low voltage BEMS cables shall be run in screened twisted pair cables to the Trend standard specification. They shall be affixed to tray, drawn into conduit or trunking and protected as agreed with the engineer to suit the various environmental, social and mechanical locations. 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 securing clamps. Any such connecting boxes shall be shown on the record drawings. No trays, conduits or cables are to be affixed horizontally at floor or pedestal level.

Where cables are connected to sensors measuring extreme heat, the necessary thermal breaks, local connecting cables are to be supplied. No BEMS 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 BEMS field device shall be identified (internally on space temperature and humidity sensors) with a common code used on points and wiring schedules, parts lists, control strategy, MCP and installation diagrams/drawings.

All BEMS 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 feeds 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.

Each outstation shall be provided with a schedule identifying the points connected to the I/O terminals inside the panel door.

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.

1.12.7 Commissioning

- (a) The BEMS 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. Demonstrate as agreed with the engineer prior to starting plant in BEMS auto mode
- (c) Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective as soon as practical once BEMS control mode is selected
- (d) Sensors shall be checked to ascertain accuracy within limits, pressure switches checked for switch points and hysteresis
- (e) All the necessary test equipment and materials used in commissioning shall be supplied by the BEMS 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 BEMS specialist shall allow one additional full day by his commissioning engineer to revisit the system at a later date (after hand-over). He shall check and adjust operational parameters, and re-tune any control as maybe required by change in the control system load conditions or bedding-in of the plant
- (h) 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

- (i) Once any item of plant is commissioned and left running to the dictates of the BEMS, documentation showing the overrides, control and software configuration shall be available on site at all times. All system documentation shall be in accordance with Trend standard templates.

1.12.8 Acceptance Demonstrations

The BEMS specialist shall give seven days notice to the engineer of his intention to provide the acceptance demonstrations once the commissioning is complete. The operation of all safety interlocks shall be tested and ten per cent of all points shall be selected by the engineer and demonstrated for operation/accuracy. Should more than 1% fail performance test, a further ten per cent may be selected. If above 1% fail he may at his discretion demand 100% demonstration. The BEMS specialist shall supply sufficient man-power/test equipment, consumable items and portable telephones to conduct the demonstration efficiently. Testing shall also incorporate an audit of the 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.

1.12.9 System Handover

The BEMS specialist shall ensure the following are completed at hand-over:

- Any snagging to be documented and agreed date determined for clearance.
- All passwords/PIN numbers, levels and operators recorded.
- Disk copies of all system and data files supplied.
- Proprietary software manuals & 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.

1.12.10 Documentation

Three copies of all final operating and maintenance manuals will be supplied within two weeks of hand-over, two on CD and one in an A4 binder. Preliminary copies shall be available to the client during this time. All system documentation shall be in accordance with Trend standard templates.

Operating Manuals shall comprise instructions on equipment safety checks, start-up and closedown 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 diagrammatical (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 instructions shall be provided for each item of equipment. Diagrams showing the 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 marked up architectural drawings, which will be free-issued to the BEMS specialist.

All drawings relating to the BEMS will be supplied A3/A4 sizes bound into A4 ring binders. These shall include system, outstation and user terminal configuration diagrams, listings and flow charts.

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 hand-over 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 client's engineer at hand-over.

1.12.11 Site User Training

The BEMS specialist shall supply the following training for the clients engineering staff.

General Engineering Staff:

On-site; while the clients engineer will attend the acceptance demonstrations, the BEMS specialist shall instruct them in the specific application of the system, the structure and the control strategies adopted to meet the specification.

1.12.12 Warranty, Support Period & Maintenance

The warranty period shall run for twelve months following hand-over, during which time the following facilities shall be available to the client.

- (a) Call-out during normal working hours within 48 hours and same day if before 10.00am
- (b) Replacement and labour for defective parts
- (c) Fault diagnosis and rectification.

Each manufacturer shall provide a quotation along with his bid for a full maintenance contract to commence after warranty providing all the facilities as described above.

1.12.13 Capacity

A minimum of 20% spare capacity shall be left in new outstations and control panels.

1.12.14 Control Panels

The control panels will be constructed in three sections, cable entry section, power equipment and controls.

All grouped controls shall be enclosed in purpose-made panels. The approximate location of the panels shall be as indicated, but final positioning shall be agreed on site.

The control panels shall be delivered, off loaded, positioned and secured.

Control panels shall be manufactured from cold rolled sheet steel of minimum thickness: enclosure 1.5mm, door 2.0mm and mounting plate 3.0mm, double folded and seam welded to form a rigid construction with no sharp edges or corners will be power coated to RAL7035 with a zinc plated mounting plate. Wall mounting brackets and screws, rails, mounting plates and gland plates shall also be suitably corrosion protected (galvanised).

Panels shall be totally enclosed, internally wired with no live terminals or components exposed. Earth continuity shall be provided to the panel doors, instrument panels and gland plates.

The design of the control panel shall be such as to enable all normal maintenance to be carried out from the front of the panel through hinged doors.

Doors on wall mounted control panels shall be semi-recessed with 180° opening, concealed type lift off hinges, compression locks and 2 No. metal removable handles.

Floor mounted panels shall be either of the cubicle type or glanding type.

Each cupboard type floor mounting panel shall have single doors for widths up to 800mm and double doors for widths over 800mm. The doors shall be secured with lockable lever handles having three point closure and 2 No. spare keys.

Floor mounted panels shall be provided with plinths, lifting eyes and bottom plates.

The pneumatic sections of control panels and all adjustable control equipment shall be compartmented to allow access without the necessity to isolate the door interlocked main isolators.

All doors and openings shall close on to neoprene or rubber gasket seals.

The layout of equipment within control panels shall be designed so as to provide sufficient space for maintenance and for the termination of the relevant tubing and cable sizes. Double banked terminal blocks shall not be permitted. All work shall be closely co-ordinated with that of the Electrical Installation in every respect, and adequate cable entries shall be provided in approved locations prior to manufacture. In addition, details shall be obtained of the incoming and outgoing cables and due allowance made both in the size of the panel for cable bending radii and for spreading, and in the size of terminations for the cable core dimensions. Cable and tubing entries shall be complete with blank stove enamelled gland plates.

The internal equipment mounting plate shall be finished in white and all equipment shall be secured to purpose made rails or mounting plates secured by shake-proof screws and washers or other vibration resistant fastenings.

Control equipment within the panel shall be identified with traffolyte type labels or printed "back of panel markers".

Internal wiring shall be fully identified at each end of each cable by numbered ferrules with power wiring and control wiring segregated and enclosed in separate PVC slotted ducting with removable covers. Wiring to equipment mounted on doors shall be enclosed in spiral wound plastic sheathing or secured with plastic harness straps.

Wiring which crosses door hinges and/or is subject to possible movement, shall be PVC insulated flexible stranded cable. All cables shall be sized to meet particular current requirements and shall be protected by suitable rated fuses. All conductors serving three phase equipment shall be coloured in accordance with the following: -

L1 Brown

L2 Black

L3 Grey

All conductors shall be manufactured from electrically pure copper.

Each panel shall be complete with door interlocked mains isolator which shall also isolate all incoming control cables etc, that are fed from a different source of supply. The isolator shall be suitably labelled ON/OFF and be complete with a warning label indicating the presence of '415 volts 3 phase' or the relevant voltage to be employed.

All indicator lamps shall be of the single point LED type and colour coded generally to BS 4099 Part 1 with schedules submitted for approval.

All switches shall be of the rotary type suitable for the required individual operation.

All primary and secondary circuit protection will be provided utilising miniature circuit breakers.

All starters and contactors shall be Allen Bradley manufacture, or equal and approved.

All equipment employed in the construction of the control system shall conform to the relevant British Standard and IEE Regulations current at the time of manufacture.

The pneumatic sections of the panels shall be complete with all necessary electro-pneumatic and reverse acting relays, receiver controllers, pressure reducing valve sets and all associated equipment to provide a complete and working installation. The tubing and fittings on the pneumatic copper materials shall be correctly bracketed and earthed, and installed in a neat and workmanlike manner.

The control apparatus on the panel fascia shall include 'Panel Live' and 'Control Circuit Failed' lamps with associated fused protection and shall be mounted and identified on white traffolyte labels in one complete section. The traffolyte shall be secured by plastic rivets and shall be engraved in black lettering in general, but red lettering for fire equipment or cautionary information, where approved.

All indicator lamps, rotary switches, push buttons, instruments and controls mounted on the panel shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and to simplify maintenance.

Externally visible equipment shall be flush mounted with minimum projection and shall be fixed securely to the front panel or other members.

All panels shall be delivered with sufficient packing to prevent damage in transit, this should include bubble wrap and or stretch film wrapping.

A functional test simulating operation of the complete panel shall be performed at the manufacturer's works prior to delivery to site. Notification shall be provided of when the works inspection and test is to be carried out. Panels shall not be encased in protection and despatched until fully approved in writing.

Unless denoted otherwise in the Specification, the following methods of starting motors shall generally be used:-

Up to and including 7.5 kW - Invertor Drive

Above 7.5 kW - Invertor Drive

1.12.15 Wiring

The incoming electrical power wiring to the control panel and fire alarm link shall be by the Electrical Contractor. The panel wiring, outgoing power and control wiring to be by the Controls Specialist. The controls specialist shall advise the Electrical Contractors of all wire requirements.

1.12.16 Monitoring

All temperatures, pressures, alarms, run/fail etc. are to be monitored. Temperature set points are to be adjustable from a remote BMS. All start/stop facilities shall be capable of activation from a remote site.

Time schedules shall be capable of being changed from a remote site.

1.12.17 Supervision, Testing, Setting To Work, Commissioning, Calibration And Proving

The controls supplier shall accept total responsibility and include for the services described below.

The services shall include all necessary visits to site by the control Supplier to carry out the following:-

1. To identify and locate the control equipment and advise on the correct method of installation.
2. To discuss with and advise all parties on the correct method of wiring and connecting the equipment.
3. To check that the equipment has been correctly installed.

4. To check that the electrical wiring has been correctly installed and connected, including electrical continuity test by the control manufacturer upon completion of the wiring installation.
5. Pre-commission control equipment at testing and balancing stage of each plant.
6. To commission the installation and to issue, in triplicate, a certificate of commissioning, which must be complete with all control equipment settings. The certificate shall not be issued nor the system accepted until the system has been demonstrated in full operation to indicate the various control actions and the satisfaction of the design conditions to the acceptance of the Architect.
7. Continuously monitor the system and building conditions for a period of two weeks to ensure stabilisation of the building and control systems. This monitoring shall not commence until item 6 above has been accepted. The Contractor shall include for the provision of all temporary monitoring equipment to allow this exercise to be carried out.
8. Instruct the Clients staff in the running and maintenance of the automatic controls installation in accordance the Hospital requirements.
9. A further visit and report shall be made immediately prior to the termination of the defects liability period to ensure the complete and accurate operation of the equipment.

1.12.18 Particular Specification

The Control system shall have UPS battery backup to enable controls to function in the event of a power failure. There will be a hard wired interlock from a volt free contact (break on alarm) on the fire alarm system to stop the supply fans on a fire condition. The extract fan will continue to run.

Heat Recovery and AC System

The new heat recovery system and AC System shall be monitored on the existing BMS for fault signals. The systems will use their own integral controls with PIR motion sensors for occupancy control.

Fire Alarm Interlock

The new automatic control system shall have the facility to interlock with the building fire alarm system. If the fire condition is detected the system controlled from the panel shall immediately shut down.

Following reset of the building fire alarm, the plant shall automatically restart in a staged manner to limit start up surges. A fire alarm active lamp on the control panel fascia indicates fault status.

Alarms

All alarms shall be agreed with the site estates services on demonstration and priority.

Control Valves

All control valves and actuators are to be supplied by the controls specialist.

1.13 COMMISSIONING AND TESTING

1.13.1 Extent of Works

The Contractor shall include for each element of the works to be tested and commissioned as required by the relevant sections of the specification.

1.13.2 General

The Testing, Setting to Work, Regulation, Commissioning and Proving of all the installations shown on the drawings and as described in the Specification shall be completed in accordance with this Section.

The above procedures shall include the following:-

Testing

The physical testing and checking of the system to prove the integrity of the installation, including pressure and leakage testing, where appropriate.

Setting to Work

The process of setting the static systems into motion including cleaning and sterilisation, chemical treatment, and the process of starting and checking all plant and equipment.

Regulation

The process of adjusting the rates of flow in the distribution systems to achieve the values stipulated in the specifications and drawings. The process shall include measurement of all variables and conditions within the systems to demonstrate that the design parameters have been achieved.

Commissioning

The process of checking and adjusting all plant, equipment and installation components to ensure that the systems operate in accordance with specified conditions and manufacturer's requirements.

Proving

Further monitoring and testing of the complete installations to demonstrate that the systems operate and control within specified environmental parameters.

Recording of space and plant conditions and provision of simulated loads will form a part of the proving process, where specified in the Supplementary Specification.

It is essential to ensure that the installations operate in conformity with the requirements called for in the design specification and drawings and no approval of site measurements will be given until such conformity is achieved. The installations will not be acceptable for handover until all commissioning and testing has been completed and approved.

The Architect shall be given the opportunity to witness all testing and commissioning and shall have access at all reasonable times to such parts of the Works, and of any

Supplier's Works, as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance of plant.

Seven days written notice shall be given of the intention to carry out any test and all necessary adjustments shall have been carried out prior to commencing such test.

In the event of the works being incomplete and causing a postponement of the notified test date, or of the installation failing to pass the test or commissioning, the right is reserved to deduct from the Contract Price all reasonable expenses incurred by the Employer's representative in attending repetitions of the test.

Allowance shall be made for testing and commissioning the installation in sections in order to conform with the programme, including sectional testing of systems which are to be concealed or insulated prior to the main test being carried out.

All labour, supervision, materials, power, fuel, stores, apparatus and properly calibrated and certified instruments for carrying out testing and commissioning in accordance with the Specification shall be included.

Allowance shall be made for attendance by the Employer's Insurance Company Inspector to witness all testing of pressure vessels and accessories in accordance with the Factories Act.

Throughout the testing the safety of all personnel and equipment in the test area shall be maintained.

1.13.3 Codes of Practice

Testing and Commissioning of the installations shall be carried out in accordance with the relevant British Standards and Codes of Practice, the BSRIA Application Guides and the CIBSE commissioning codes:-

- A** Air Distribution
- B** Boiler Plant
- C** Automatic Controls
- M** Commissioning Management
- W** Water Distribution.

The CIBSE codes are obtainable from The Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London, SW12 9BS.

A full set of the relevant guides and codes shall be kept permanently on site and the commissioning engineers shall be fully conversant with methods outlined therein.

1.13.4 Instruments Used in Testing

The instruments used during the commissioning and testing shall have been re-calibrated by the Manufacturer prior to carrying out any measurements on site and shall be of the types detailed in the relevant BSRIA Application Guides.

Manufacturer's instructions relating to test instruments shall be strictly adhered to.

Written documentation shall be submitted, from the instrument manufacturer's, confirming the accuracy of the instrument and its serial number in order to demonstrate that the instruments being used are bonafide and capable of registering to the degree of accuracy acceptable.

Manufacturers of plant who put forward their own test figures for inclusion shall also state, in writing, the type of instruments used to obtain the figures quoted.

1.13.5 Specialist Commissioning Engineers

Specialist commissioning engineers shall be employed to carry out the site regulation, setting to work, commissioning and proving.

The engineers shall be fully trained in the use of test instruments and methods of testing and commissioning and the right is reserved to require the removal from site of any engineer who is deemed to be unsuitable for the required task.

The commissioning of all items of plant and equipment and their associated control and electrical systems shall be carried out by the Manufacturer's authorised engineers.

1.13.6 Equipment & Commissioning Certificates, Schedules and Drawings

The design data for items of plant and equipment is generally as summarised on the design drawings and in the Specification.

Equipment and commissioning schedules shall be completed and submitted during commissioning, indicating the design conditions, site test readings and observations.

Schematic drawings of all systems shall be provided by the Contractor detailing the design data and locations of all measurements and tests. These drawings, in conjunction with the schedules, shall provide a complete record of design and test data for all sections of the various systems.

Upon completion of final balancing and commissioning of the systems, the test results shall be submitted in duplicate to the Architect for comment.

The approved Equipment and Commissioning Schedules shall then be incorporated into the Operating and Maintenance Instructions.

Two copies of "as made" drawings of all tanks, receivers, calorifiers, pressure vessels and boilers producing water or steam above 100°C, shall be submitted to the Employer's Insurance Company, prior to manufacture.

Two copies of all test certificates shall be provided, in addition to which copies shall be incorporated into the Operating and Maintenance Instructions.

1.13.7 Pre-Commissioning Flushing, Cleaning, Chemical Treatment and Sterilisation

The Contractor shall employ a reputable specialist to carry out the flushing, chemical cleaning and treatment of all systems.

This specialist shall be responsible for water analysis including the mains supply and for the design, supply, installation and operation of the flushing, cleaning and chemical treatment processes.

The flushing and chemical cleaning of LPHW and chilled water systems shall be carried out in accordance with BSRIA Application Guide 8/91. All treatment shall comply fully with Statutory Authorities Health and Safety Regulations.

All manufacturers and suppliers of equipment incorporated into the wet systems shall be notified of the proposed cleaning and chemical treatment processes and their approval obtained. Manufacturers or Suppliers recommendations in relation to cleaning or chemical treatment shall be adhered to.

Prior to carrying out chemical cleaning and/or treatment processes, the following actions shall be taken.

- All foreign matter shall be removed.
- Certified pressure tests shall have been carried out.
- All water used for pressure testing shall be inhibited. Remaining sections shall be left full after pressure testing.
- Where there is a risk of freezing inhibited mono-ethylene glycol shall be used.
- Circulation shall be demonstrated on all parts of the system. All valves other than those used to isolate sections shall be left fully open. Balancing and certification of water systems shall be carried out after the flushing cleaning and passivation operations.
- Ensure that no damage shall occur to any item of plant or equipment as a result of the cleaning and chemical processes.
- Chemicals used shall be compatible with system materials.
- Temporary bypasses shall be provided as necessary.
- Dirt pockets shall be installed at low points to facilitate solids removal.
- Check all drainage, to be used when discharging water or effluent from the systems has been tested and approved and that the drainage system is fully operational.
- Dead legs more than 3 pipe diameters in length shall be looped to allow effective cleaning.
- Strainer baskets and filter media incorporated within systems shall be removed and where necessary stool pieces installed.
- Temporary strainers and filters shall be installed as required for removal of solids during cleaning and chemical treatment processes.
- Suitable supply and drainage points shall be provided with 50mm minimum connections, properly sited and installed either valved or plugged.
- All automatic/manual air vents shall be fully commissioned.

- All COSH regulations shall be complied with during the chemical cleaning and treatment of the system.
- Where required by the Local Water Authority, effluent tanks shall be provided for the storage of all waste products of cleaning and chemical treatment processes.
- After obtaining Local Water Authority approval, the waste produces shall be neutralised and discharged to drain or disposed of by removal to an authorised registered site.

After completion of the chemical cleaning the right is reserved to instruct the removal of up to ten sections of the pipework installations and to have them inspected and examined.

If the test and inspection should prove that the cleaning is to the required standard, the Employer will pay the costs incurred in removing, testing and replacing the sections of the installation. If, however, the test and inspection show that the cleaning is below standard and incomplete, no costs or fees incurred by the tests shall be borne by the Employer.

If any result suggests that cleaning the whole installation or system is incomplete, the pre-commissioning cleaning shall be continued until the witnessing is to the satisfaction of the Architect. The right is reserved to deduct from the Contract Price all reasonable expenses incurred by the Architect in attending the repetition of the witnessing.

Immediately upon completion and approval of the pre-commissioning cleaning, the water treatment of all systems shall be carried out as described elsewhere in the Specification.

An approved water treatment specialist shall be employed to carry out the flushing, sterilisation and chlorination of all new domestic hot and cold water installations, and existing installations where alterations have been made, including incoming and rising mains, tanks and tank cold water down services.

The sterilisation and chlorination shall be carried out in accordance with BS CP 310 (BS 6700) with a minimum concentration of 50 mg/litre circulated for 3 hours and an independent testing laboratory shall be employed to certify that water from each system is free from any bacterial contamination.

A further set of tests shall be carried out during the Defects Liability Period to ensure any "hide out" of bacteria due to latent contamination is not present.

If the tests prove the presence of bacteria, the re-chlorination of any or all systems shall be undertaken at no extra cost.

All sterilisation, chlorination and pre-commissioning cleaning shall be carried out in accordance with the requirements of the Local Authority.

1.13.8 Pipework Testing, Commissioning and Regulation

All water systems shall be tested, commissioned and regulated to ensure that they operate with the correct performance, temperatures, pressure and flow rates in accordance with the Specification and drawings.

The whole of the pipework installations shall be hydraulically tested to twice the working pressure of the system or 4 bar, whichever is the greater. This pressure shall be maintained for a period of two hours in each case, and allowance shall be made for attendance upon the Architect during the progress of such tests. Arrangements shall be made for the Water Authority to witness these tests, should they require to do so. Any equipment fitted which is not suitable for the test pressure shall be adequately protected or isolated from the system during the test.

Regulation shall be carried out in accordance with the relevant BSRIA Application Guides and CIBSE Commissioning Codes.

1.13.9 Ductwork Testing, Commissioning and Regulation

All air systems shall be tested, commissioned and regulated to ensure that they operate with the correct performance, temperature, pressure and flow rate in accordance with the Specification and drawings.

The ductwork pressure classifications shall be as detailed in the Supplementary Specification relating to this Project.

All air handling equipment and air system plant components shall be measured and tested for pressure differential and flow rate to ensure that the installation and manufactured components comply with published and specified data.

The measurement of velocity within a ductwork installation, to determine volume flow shall, unless stated otherwise, be carried out in accordance with BS 1042.

Regulation shall be carried out in accordance with the relevant BSRIA Application Guides and CIBSE Commissioning Codes.

1.13.10 Ductwork Air Leakage Testing

Air leakage tests shall be carried out in accordance with DW/143 and DW/144. The maximum leakage rates shall be as Table 17 of DW/144.

"High Pressure" classified systems shall be tested.

"Low" and "Medium" classified systems shall be tested where required in the Supplementary Specification.

The ductwork pressure classifications shall be as detailed in the Supplementary Specification relating to this Project.

The results of the leakage tests shall be submitted in the manner indicated on the Specimen Test Sheet in DW/144. The measurement on site of duct lengths, cross-sectional area, and surface area of the ducts under test shall be carried out and recorded at the time of the test.

All supply and extract and recirculation air ductwork on VAV and Induction unit systems shall, unless stated otherwise, be tested generally in accordance with DW/143 and DW/144 high pressure air leakage tests.

1.13.11 Commissioning Notes form Guidance Note 7 (Issue for Information)

General Commissioning Notes

The following is an extract from the Guidance Note 7 regarding commissioning and the items listed shall be included in the commissioning checklist.

Commissioning

The commissioning procedure should be sufficiently thorough and systematic so as to identify, together with the normal site inspection, any obvious installation deficiencies and design errors and omissions. The Contractor is responsible for the rectifications of defective work but problems which result from the design are obviously the responsibility of the Design Engineer.

As an immediate preliminary to the setting to work of an installation a full check and inspection shall be carried out to confirm that the installation and its components are in a safe and satisfactory condition.

Due to the health danger the Designer, Contractor and Site Engineer have a duty to ensure that the design/installation of the system and the materials used are such that the conditions which encourage the colonisation of micro organisms do not exist. Any part of the system which is likely to create such a hazard should be drawn to the attention of the Design Engineer by the Site Engineer if it is beyond the responsibility of the Contractor.

The installation and control of 3 way or diverted valves shall be checked to ensure compliance with the manufacturers recommendations to ensure that there is a correct water flow balance within the system and the operating temperatures are in accordance with the design.

Commissioning should take place until all are satisfied that the system is free of such hazards and details of correct and safe operation of all systems and controls are available and fully understood.

Similar care to ensure safety should be taken to ensure that no parts of the system are subject to back siphonage. Consideration should be given to inviting the local Inspector to visit the site prior to commissioning to ensure that the systems are in compliance with local bye-laws and recommendations and in an acceptable condition.

The purpose of commissioning a potable water installation is to determine that the quality and purity of the liquid which is available at each outlet point is of the required standard. In this connection the procedures adopted for medical gases should also be used for potable water.

Before the installation is handed over to the User the following checks and tests should be carried out by the Contractor:-

.001 Pressure test, for leakage in pipelines only.

- .002 Check valve tightness.
- .003 Pressure test for leakage in completed installations.
- .004 Check for cross connections between different water systems.
- .005 Purge the completed installation with water to ensure the internal cleanliness of the system.
- .006 Sterilise the complete system.
- .007 Rinse the sterilised system with clean water from the Water Authority's mains.
- .008 Determine that the sterilising agent has been completely washed from the system.

After completion of the above and before the installation is brought into use, the following additional tests shall be carried out.

- .009 Check the quality and purity of water at selected outlet points and potential danger points elsewhere in the system.
- .010 Check for Legionella at selected outlet points and potential danger points elsewhere in the system.
- .011 Following completion, issue a certificate which should be included in the commissioning manuals against which the integrity of the system can periodically be tested.

All tests should be clearly documented and the results of tests witnessed shall be initialled. Purity and legionella tests shall be witnessed and initialled by the Hospital's nominated Control of Infection Officer preferably a Microbiologist or nominated representative.

Operation manuals shall include full procedures to ensure that the Hospital Engineer is fully aware of the requirements for the care of all new equipment including maintenance, treatment and subsequent monitoring and recording.

Demonstrations shall be arranged if there are any doubts of the ability of the Hospital Works Staff to be able to care for the new systems.

For extensions to an existing system a "Permit to Use" system should be used to protect the potential user from being supplied with an impure liquid from an outlet.

Temperature Testing

On water service systems, temperature testing shall be performed before and after practical completion. Separate thermometric measuring and recording equipment is recommended, e.g. multi-channel recorders. It will be necessary to have systems fully operational and to simulate typical draw-off of water.

The tests shall include:-

.001 Testing the inlet, outlet and surface water temperature of cisterns and cold water feed/header tanks. This should be less than 20°C.

.002 Testing the flow and return temperature of calorifiers and boilers. This should be 60°C ± 2.5°C and not less than 50°C respectively.

.003 Testing the temperature of hot and cold water draw-off points at sinks, wash hand basins, baths etc.

Hot Water - steady state 50°C to 60°C within one minute of full flow.

Cold Water - less than 20°C within two minutes.

Testing the mixed water temperature thermostatic mixing valves. A maximum of available temperature of 43°C + 2°C is required otherwise the mixing valve must be replaced. The cold water should be turned off to measure the security of the fail-safe system. Bidets should be tested 40°C ± 2°C.

Sterilisation (Disinfection)

Sterilisation of water systems is covered by BS 8558 and BSEN 806. Although the term “sterilisation” is used in the text and generally throughout the industry, it should be recognised that the process described is a “disinfection” process and that the water is not sterile as a result.

The British Standard states that:

- “a) All mains and services to be used for water for domestic purposes should be thoroughly and efficiently sterilised before being taken into use, and after being opened up for repairs.
- b) The sterilisation of mains should be carried out by specialists. Service pipes should, if possible, be disinfected together with the mains”.

The recommended procedures are as follow:-

- (i) Installations outside buildings.

Pipework under pressure from the mains should be chlorinated through an injection point and the free residual chlorine measured at the end of the pipeline.

It is normal water industry practice to use a dose of not less than 20 mg/1(ppm), and because the nature of the installation is likely to lead to unavoidable contamination, it is usual practice to leave the chlorine solution in the pipes for 25 hours before thoroughly flushing out with fresh water.

All chlorination of pipework under pressure from the mains must be carried out in accordance with the requirements of the local water undertaking. Failure to ensure close liaison between the Contractor and the Water Authority during design, construction, pressure testing or commissioning could present a potential risk of back siphonage of contaminated materials or chemical sin to the public water supply. Site supervision to ensure

compliance with any requirements specified by the local Water Authority is strongly recommended.

(ii) Cold water installations within buildings

All cistern(s) should be internally cleaned to remove all visible dirt and debris. Cistern(s) and distributing pipework should be filled with fresh water and then drained completely. The cistern(s) should then be refilled and their supply servicing valves closed.

During these procedures it is normal practice to apply high doses of sodium hypochlorite to the water in the cistern(s), e.g. to give a calculated chlorine concentration of 50 ± 10 mg/1(ppm) in water, and leave the water to stand for 1 hour. The concentration should be checked, and should be above 30 mg/1. If this residual level is not achieved, the process should be repeated. The use of high doses ensures an adequate residual concentration to allow proper disinfection of the down stream services. Each tap or fitting should then be opened, progressively away from the cistern(s), and water discharged until a chlorinous odour is detected. Each tap or fitting should then be closed, and the cistern and pipes left charged for a further 1 hour. The tap(s) furthest from the cistern(s) should be opened and the level of free residual chlorine in the water discharged from the tap(s) measured. A concentration of free residual chlorine less than 30 mg/1(ppm) indicates that the disinfection process has been unsatisfactory and it should be repeated.

As soon as possible after disinfection, the distribution pipework should be drained thoroughly and flushed through the fresh water until the free residual chlorine concentration at the taps is no greater than the present in the mains water entering the building: water should not be allowed to remain in the system overnight. Appropriate hazard warnings should be placed on the taps throughout the building during chlorination procedures.

(iii) Hot water installation within buildings

Cold feed cisterns, hot water calorifiers, water heaters, direct fired HWS boilers, should be disinfected in accordance with (ii) above: no heat source should be applied during the procedure, including final flushing. After the disinfection process they should be flushed thoroughly, brought up to operating temperature before the entire distribution system is flushed out.

(iv) Discharge of waste water used during disinfection procedures within buildings

Authorities responsible for sewers require to be informed before chlorinated water used for disinfecting an installation is to be discharged. It is preferable therefore to establish and agree procedures beforehand; this may involve simple dilution of the discharge or de-chlorination.

When required, de-chlorination can be achieved using either sulphur dioxide or sodium thiosulphate. (20 g of sodium thiosulphate crystals are required to de-chlorinate 500 litres of water containing 20 mg/1 free chlorine).

The term “free residual chlorine” refers to the chlorine after it has been in contact with the system. It is absorbed by organic matters in the water, the

level decreases with time therefore further checks are required, (and further fluid added) at intervals throughout the disinfecting period.

The domestic hot water system shall be similarly disinfected.

The process of disinfecting the mains must be undertaken systematically commencing at a $\frac{3}{4}$ " dosing valve injection point in the incoming main immediately downstream of the main isolating valve. Included should be all drinking water points taken off the rising main and those pipes which terminate at the ball cock valve serving the various storage tanks.

For systems with a small amount of town supply pipework the volume of water required to fill this pipework is not very great and can be reasonably pre-determined. It is suggested that when this quantity is known a receptacle of appropriate size be filled with water to which the disinfecting agent has been added in the correct proportions and by means of a small pump the installation is filled until chlorine is available in the right proportions at all outlets as described in the British Standard.

For larger systems the pipework is filled with water and by opening a hydrant to wash out and to maintain the main fully charged but under a selected displacement rate, chlorine is then added at a rate consistent with the displacement rate. This work should only be carried out by specialists.

Disinfection of the main should only be attempted after the following pre-requisites have been accomplished:-

- 1) The main has been pressure tested.
- 2) The main has been well flushed or preferably swabbed to remove foreign matter and thereby diminishing chlorine demand.
- 3) A $\frac{3}{4}$ " dosing valve has been inserted in the section immediately downstream of the isolating valve between the old and new sections.
- 4) The length and diameter of the main is known
- 5) Sampling points should be provided to facilitate future testing.

Prior to handover, all systems shall be proved to be microbiologically clean by the taking of water samples which shall continue into the period between handover and full occupation of the buildings and flushed at weekly intervals to prevent stagnation.

If necessary disinfection shall be repeated. The whole procedure shall be monitored and recorded. Evidence suggests that *Legionella Pneumophila* establishes itself during this period.

All humidifiers and chiller batteries shall be disinfected using chlorine at 5 ppm immediately prior to handover.

To ensure disinfection it is for the Design Engineer with Specialist advice to formulate the initial treatment programme.

The Contractor shall commission the system and regularly monitor it until Practical Completion and if necessary correct the treatment programme with the advice of the

specialist. The Contractor's responsibility must be clearly stated in the tender documentation.

The use of biocides and algaecides if required should not replace the chlorination procedures but be compatible with them.

A commissioning and during the water treatment regimes a regularly and frequent intervals, all valves shall be operated over the control range to ensure that all sections of the water systems are exposed to treatment. Valves and any bypass lines and pipeline manifolds to standby pump installations or serving ancillary equipment should be similarly operated to ensure adequate treatment.

1.14 RECORD DOCUMENTS AND CLIENT DEMONSTRATION

1.14.1 General

Four weeks prior to Practical Completion, in addition to the requirements of the Preliminaries Document, the Contractor shall provide to the Architect for distribution four approved sets of the bound record documents comprising Record Drawings and Operating and Maintenance Manuals as described below, together with:

Two sets of top quality paper prints of the Record Drawings.

The Record Documents shall comprise of the following:

1.14.2 Record Drawings

The Mechanical Contractor may note that original Redworth Associates electronic versions of drawings are available for use by the Mechanical Contractor for modification/re-submission for the “as fixed” drawings.

The number (and general content) of separate “as fixed” drawings required for this scheme shall be not less than those listed in this specification, plus any other drawings issued by Redworth Associates during the contract period, or any additional drawing deemed necessary by the Engineer.

On practical completion of sectional completion of the works and before the release of any retention Fund, the Mechanical Contractor shall, at his own expense, supply to the Engineer “as fixed” drawings consisting of the following:-

- Two complete sets of white prints.
- Disks containing all As Fitted drawings in Autocad latest format.

The above drawings, which shall be executed by a competent draughtsperson, must be in sufficient detail to enable the Trust’s Engineering staff to maintain, dismantle, re-assemble and adjust all parts of the works.

Floor layouts shall be to a scale of not less than 1:50.

Plant rooms, boiler rooms and equipment rooms shall be to a scale of not less than 1:20.

The drawings shall include symbols, plans, sections, elevations to provide a comprehensive record of the installations.

Electrical drawings shall be in accordance with IEE Regulations and with this Specification.

1.14.3 Operating and Maintenance Instructions

The Contractor shall provide operating and maintenance instructions containing all information to enable the Client to operate and maintain the installations and equipment, comprising fully detailed sections including the following:

Description of the system and equipment, including diagrammatic drawings of each system.

Setting to work and operating instructions of plant including safety precautions.

Schedules of routine and periodic maintenance.

Schedules of emergency measures and fault finding techniques.

Schedules of equipment with manufacturer's works/reference numbers, names, addresses and telephone numbers.

Manufacturers instruction leaflets and literature including lists of standard replacement parts.

Schedule of valve numbering/electrical circuits etc., and operation.

Set of white paper prints of installation drawings to be replaced with prints of record drawings when completed in accordance with the Specification.

Description and schedule of control sequences together with wiring diagrams indicating plant and control interconnections and internal wiring of equipment.

The documents shall be bound in stiff-backed ring binders and shall be A4 size, finished in black welded PVC with "pull open" two ring fitting at 80mm centres and of a capacity to suit the intended contents.

All the contents shall be mounted in clear PVC pockets sealed on three sides, open at the top and punched at 80mm centres.

The Contractor shall include for all costs and expenses in this context and shall indicate the item separately in his Tender Summary.

It shall be a condition of the tender that should the Architect deem the amount to be inadequate for the purpose, it shall be in the Architect's power to recommend that a common amount be employed for the purposes of comparison of Tenders and that the Contractors shall become liable for such sum as is such sum had been included, subject to the Tenderer having been given the option to confirm or withdraw his Tender.

In the event of the Contractor failing to comply with this Clause in the stipulated time for production etc., the Architect shall have the power to recommend the Contract Works as being unacceptable to hand over due to the insufficient information being available to enable the plant to be operated and maintained in accordance with the Health & Safety at Work Act, and furthermore shall have the power to instruct the work to be carried out by others and deduct the resultant costs from the Contractors Final Account.

1.14.4 Training of Client Staff

The Contractor shall allow for the Person in Charge to instruct the Client's staff in operating, maintaining and servicing the entire plant. The Architect will give seven days written notice of his requirements for this period of instruction to commence.

The Contractor shall allow for instructions on specialist equipment or systems to be given by the manufacturers/suppliers.

1.15 QUERIES

1.15.1 General

Should the Contractor have any queries regarding the Specification or drawings he should contact:-

Robert Sutcliffe
Redworth Associates
Ryefield House
180 Highgate Road
Queensbury
BRADFORD
BD13 1DS

Tel N^o: 01274 577 171

Email: Robert.sutcliffe@redworthassociates.co.uk

SECTION 2

GENERAL PREAMBLES AND PRELIMINARIES

- 2.1** The Mechanical Contractor shall refer to and comply with the Main Contract Documentation.

SECTION 3

GENERAL REQUIREMENTS

3.1 DEFINITIONS

Mechanical Contractor – Where this term is used within the specification it shall be taken as the contractor completing the mechanical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Mechanical Contractor shall equally refer to the Mechanical Sub-Contractor or Building Services Sub-Contractor.

Electrical Contractor – Where this term is used within the specification it shall be taken as the contractor completing the electrical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Electrical Contractor shall equally refer to the Electrical Sub-Contractor or Building Services Sub-Contractor.

Specialist – Refers to a specialist contractor employed by the Building Services Contractor, Mechanical Contractor or the Electrical Contractor to complete part of the works on their behalf, the Building Services Contractor, Mechanical Contractor or the Electrical Contractor shall be fully responsible for all works undertaken by the specialist.

Services Contractor – Where this term is used it shall refer equally to the Mechanical and Electrical Contractor completing the mechanical and/or electrical installation works as detailed in this specification and associated drawings etc. Depending upon the type of contract the term Services Contractor shall equally refer to the Building Services Contractor, Mechanical Services Contractor or Electrical Contractor.

Main Contractor – Where this term is used within the specification it shall be taken as the contractor completing the overall contract for the client as detailed in the main contract specification and associated drawings etc. Depending upon the type of contract this shall equally refer to the Builder, Principal Contractor or the Mechanical or Electrical Contractor if they are the Main Contractor for the project.

Engineer – Refers to a representative of Redworth Associates.

Contract Administrator – Refers to representative of the company administering the project as defined in the Main Contract Preliminaries.

3.2 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS

All works undertaken shall be completed in accordance with Construction (Design and Management) Regulations 2015.

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

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

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

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

The Mechanical Contractor shall take all necessary measures to satisfy himself/herself that all Contractors, whether appointed by him/her directly or not, are competent and have allocated sufficient resources to comply with the requirements on Contractors imposed by the Construction (Design and Management) Regulations 2015.

3.3 SCOPE OF WORK

The work shall include all services described or noted in the tender documents including the production of all information, drawings, documents, demonstrations, testing required by this specification and the Main Contract Documentation including:

- Provision of technical information for tender valuation.
- A schedule of rates
- Statement on quality control resources.
- Programme of works with ordering times etc. to be issued to the Contract Administrator and incorporated into the Main Contract programme.
- Builders work information.
- Installation drawings including ductwork drawings, control drawings, performance characteristics for electrical equipment etc.
- Record documents.
- Method statements.
- Liaison with any occupiers, owners etc. re shutdowns, connections into existing etc.
- Liaison with other Contractors and Consultants.
- Provision of costs for variations broken down and using the schedule of rates.
- Removal of redundant services and removals where noted.
- The provision of the mechanical services detailed on the drawings and in this specification including the supply of, carriage to site, storage, installation, testing, cleaning, commissioning and setting to work of the installations.

- The incorporation of all equipment, accessories, controls, supports and ancillaries required by the tender documents and/or in accordance with manufacturers recommendations and accepted current practice to allow assembly testing and commissioning to achieve the specified duties/performance.

3.4 A SCHEDULE OF RATES

A quantified schedule of rates must be submitted within one week of request.

The schedule shall be broken down to show each service, each area, with sub totals, individual items, costed and multiplied by their number to give their number and location.

It must include all items and materials included in the tender, together with their rates, extended and totalled. Preliminaries are to be separately priced. Such totals shall agree with the Subcontract Sum and subtotals shall agree with the priced breakdown of the tender.

Lump sum items will not be accepted.

Correction of errors in the quantification will not lead to adjustment of the Subcontract Sum.

Rates to include or exclude Contractor's cash discount as required by the Main Contract Conditions.

If a schedule of rates is not received pricing of variations will be by the Quantity Surveyor.

3.5 TECHNICAL INFORMATION

Technical information relating to the Mechanical Contractor's tender must be submitted within one week of request.

3.6 QUALITY CONTROL RESOURCES

A statement must be submitted within one week of request describing the organisation and resources which the Mechanical Contractor proposes and undertakes to provide to control the quality of the Contract Works. The statement must include the number and type of staff responsible for quality control, with details of their qualifications and duties.

3.7 VISIT TO SITE

Tenderers are required to visit the site before completing their tenders, and will be deemed to have satisfied themselves as to the means of access, the extent and nature of the works, the site conditions under which the works will be carried out, the conditions affecting the supply of labour and material and all other matters which may affect their tenders. Claims on the grounds of want of knowledge in such respects will not be accepted.

3.8 INSTALLATION AND DETAILING INFORMATION

Complete the detailing of the work and provide complete production information (including, as appropriate, fabrication/installation drawings etc.) based on the drawings,

this specification and other information provided, liaising with the Engineer, Contractor and others as necessary to help ensure co-ordination of the work with related building elements and services.

Provide Installation Drawings, Manufacturers Drawings and Wiring Diagrams.

Provide performance characteristics of electrical equipment.

Provide Builder's Work Information, appropriate to the stage of design development.

Co-ordination of the Engineering Services Installations will be carried out as part of the Contract.

Agree principles of co-ordination with all parties concerned.

Incorporate details provided by others into the Co-ordination Drawings.

Provide all necessary details/drawings/schedules etc. required to enable the co-ordination drawings to be prepared by others.

Ensure the installation drawings make due allowance for all building elements, structure and other services.

For services identified as Mechanical Contractor design, provide design calculations and drawings in addition to installation drawings.

Late or Incorrect Information

If delays occur due to late, incomplete or incorrect information provided by the Subcontractor, claims for extension of time, other than those allowed under the Contract, and/or additional costs will not be entertained.

Additional Information

Request, in writing, additional information as necessary from the Engineer and/or Contractor and provide design/production information as necessary in accordance with the agreed programme.

3.9 BUILDER'S WORK INFORMATION

The Mechanical Contractor shall provide detailed builders work information on drawings for comment. The details shall include positions and sizes of all holes, chases, ducts, trenches, anchors, manholes, plinths, bases, building in requirements and all making good requirements.

The Mechanical Contractor shall also confirm and amplify any builder's work information provided by the Engineer.

3.10 DRAWING TYPES

The following definitions shall apply to drawings referred to in this Specification.

3.10.1 Tender Drawings

Drawings prepared by the Engineer showing the design in such detail as may be necessary to enable those tendering to interpret the design for the Works and in conjunction with the specification to submit competitive tenders for the execution of the Works.

3.10.2 Contract Drawings

Drawings issued with the Contract Documents for the purpose of signing a contract. Tender drawings will normally be reissued for this purpose.

3.10.3 Co-ordination Drawings

Drawings showing the inter-relationship of two or more Engineering Services and their relation to the structural and architectural details. Such drawings shall be provided by the Engineer where he considers them to be necessary, in such detail so as to demonstrate that the engineering services will be properly separated from one another and can be satisfactorily installed and maintained.

3.10.4 Builders Work Drawings

Drawings prepared by the Mechanical Contractor to show requirements for architectural or structural provisions necessary to facilitate the execution of the Works and allow their integration into the Project. Such drawings shall include requirements for ducts, holes, chases, trenches, foundations, bases and supporting structures for plant or equipment and all related making good requirements.

3.10.5 Construction or Installation Drawings

Drawings prepared by the Mechanical Contractor based on the Contract Drawings showing details of the proposals for the execution of the Works. The drawings shall be in such detail including dimensions so as to enable the Works to be installed.

The Mechanical Contractor, in preparing his/her installation drawings, shall continue the design co-ordination before tender to ensure that all areas are fully co-ordinated. He/she shall liaise closely with all other trades to ensure that this is achieved.

3.10.6 Manufacturers Drawings

Drawings issued by the Mechanical Contractor to show the construction, arrangement and sizes of suppliers equipment. Such drawings shall be certified by the manufacturer and shall not be 'typical' arrangements.

3.10.7 Shop Drawings

Drawings issued by the Mechanical Contractor produced for the purpose of explaining how the components of the designs are to be fabricated.

3.10.8 Record Drawings

Drawings prepared by the Mechanical Contractor in order to provide the Employer with a record of Works as installed including details, sizes, types, locations, duties and descriptions of all plant, material, equipment and installations including "free issue" items.

The Mechanical Contractor shall take, and be responsible for, all particulars and dimensions from site and details on any drawings prepared by him/her.

Drawings shall be prepared to a scale of 1:50 for all services and builders work in the buildings and 1:20 for all plant rooms, confined spaces and similar locations.

Drawings shall include symbols, plans, sections, elevations and isometric interpretations as required to provide a comprehensive record of the installations.

The inspection of the Mechanical Contractors drawings by the Contract Administrator shall not diminish the Mechanical Contractors responsibility for ensuring both their accuracy, and their compliance with the requirements of the Specification.

3.11 SETTING OUT OF THE WORKS

The Mechanical Contractor shall be responsible for the setting out of the Contract Works and for the correctness of the positions, levels and dimensions of the works. The Mechanical Contractor shall supervise and be responsible for the accuracy of all information provided by him/her under the Contract.

If at any time during the progress of the Works any error shall appear or arise in the positions, levels or dimensions of the Works, the Mechanical Contractor shall at his/her own expense remove and amend the work to the satisfaction of the Contract Administrator and shall become liable for any costs associated with such error including any delay caused to the Contract due to such error.

3.12 DOCUMENTS AND DRAWINGS ON SITE

The Mechanical Contractor shall ensure that one copy of the current Contract Documents and Contract and Installation Drawings are kept in his/her office on site at all times and that his/her staff and operatives are fully conversant with same.

The Mechanical Contractor shall also include for keeping one set of the Installation Drawings in his/her office on site upon which he/she shall keep marked up, on a weekly basis, the installation progress as installed. These drawings shall be kept solely for this purpose and shall be kept up to date at all times together with any amendments or variations to the works which shall be recorded upon them. Failure to keep the record drawings up to date will result in a deduction on the monthly valuation.

The "marked up" set of Installation Drawings shall form the basis of the "Record Drawings" required upon completion of the works and shall also serve as a means of recording the progress of the works, in that two up to date copies shall be issued to the Contract Administrator at four weekly intervals at the Mechanical Contractors expense.

The drawings and documents on site shall be available for inspection by the Contract Administrator at all times.

3.13 PERSON IN CHARGE AND QUALITY OF WORKMANSHIP

The Mechanical Contractor shall in the execution of the Contract Works employ such employees and workmen as are careful and skilful in their trades and callings, have had previous experience of the class of work involved and shall keep on site at all times a competent person in charge, duly qualified and authorised to act for him/her in every way. The person in charge shall give his/her whole time and attention to the works for the full duration of the Contract and shall be responsible for no other contract or commitment.

The person in charge shall be fully conversant with all relevant aspects of the works and shall have had previous experience of the class of work involved.

The Mechanical Contractor shall not be allowed to replace the person in charge without written confirmation from the Contract Administrator.

3.14 MATERIALS AND WORKMANSHIP

The Mechanical Contractor shall ensure that all materials, goods and workmanship used in the works shall be the best of their respective kinds and shall conform to the current British Standard Specifications and the recommendations of the respective current Codes of Practice including test pressures, methods of testing etc.

Electrical installations shall be in accordance with BS 7671 the IEE Regulations for Electrical Installations : Latest Edition.

No materials brought to site for the incorporation into the works shall be used for scaffolding, any other temporary purpose or misused in any way.

All materials, goods or workmanship considered by the Contract Administrator to be unsound, unacceptable and/or not in accordance with the Specification shall be immediately removed by the Mechanical Contractor and properly replaced by the Mechanical Contractor to the satisfaction of the Contract Administrator at the Mechanical Contractors own expense. Should the Mechanical Contractor neglect or refuse to do this, the Contract Administrator shall have the power to employ other monies that may then be due or shall become due to the Mechanical Contractor.

Where manufactured items are not specified by name, the Mechanical Contractor shall submit these to the Contract Administrator for comment before their use is permitted.

The work shall, unless otherwise stated, be carried out in strict accordance with the recommendations of the manufacturers of the materials, plant and equipment to be installed.

The Contract Administrator may require the Mechanical Contractor to submit correctly identified and documented samples of any materials or workmanship to be used in the Contract Works for his/her approval, and the Mechanical Contractor shall allow for any charges he/she may consider necessary in complying with this condition. All materials and workmanship for which samples have been approved must conform in every respect with such samples, and any items not conforming to the approved standard shall be removed and replaced with new materials at the Mechanical Contractors own expense.

3.15 CONTRACTORS TEMPORARY ELECTRICAL SUPPLIES

All wiring, cabling etc., serving temporary installations, shall be so designed, installed and operated as to be safe and in full accordance with the appropriate regulations and details as follows:-

3.15.1 Regulations

The whole installation shall comply with all concurrent regulations as issued by the Factories Act, the Construction (General Provisions) Regulations, BS 7671, the Regulations for Electrical Installations: Latest Edition, and the relevant Codes of Practice.

3.15.2 Types of Supply

The following distribution voltages shall be considered as suitable for use on site:-

- Fixed Plant - 400V 3 phase
- Movable plant fed via suitably sheathed or armoured tracking cable (e.g. electric arc welding plant) - 400V 3 phase
- Installations in site buildings - 230V 1 phase
- Semi-permanent floodlighting - 230V 1 phase
- Portable and hand-held tools - 110V (55V to earth)
- Site lighting - 110V 1 phase (55V to earth)
- Portable hand lamps (general) - 110V 1 phase (55V to earth)
- Portable hand lamps (confined or damp situations) - 25V 1 phase

3.15.3 Protection of Circuits

Protection equipment shall be adequate to protect the system in accordance with the IEE Regulations and so arranged as to provide correct discrimination in operation.

3.15.4 Testing and Inspection

Testing and inspection shall be carried out as required under BS 7671 the IEE Regulations, Latest Edition.

3.15.5 Cables

All cables used on site, other than installed in site offices etc., shall be of an armoured or mechanically protected type when used on systems operating at voltages in excess of 55 volt to earth.

3.15.6 Earthing

The installation shall be solidly bonded to the Supply Authority's earth. In certain cases residual current devices may be necessary to comply with BS 7671, IEE Regulations Latest Edition, with particular reference to Section 604.

As soon as any part or the whole of the Contractor's temporary installation is no longer required for carrying out the Works, the Mechanical Contractor shall disconnect and remove the same to the satisfaction of the Contract Administrator.

3.16 CARRIAGE OF GOODS

The Mechanical Contractor shall allow for the cost of all packing, carriage and delivery of goods, including off-loading, required upon the site to maintain the programme and shall include for the return of empty cases and the handling of materials not required on site. His/her Tender shall include for goods delivery by passenger train or other special transport as necessary to carry out the work in the specified time. The Mechanical Contractor shall advise with his/her Tender if the delivery programme cannot be met for any item involved.

Delivery to site shall be in accordance with the agreed programme and the Mechanical Contractor shall give three weeks notice of the actual delivery to the Contract Administrator.

3.17 TEST CERTIFICATES

3.17.1 General

Where testing specific to the project is required, ensure test certificates include:-

- Project title
- Details and dates of test
- Instruments used, serial numbers, calibration dates
- Signature of those witnessing test

3.17.2 Manufacturer's Test Certificates

Insurance Company and Manufacturer's certificates of tests, at the specified duties, shall be held at the Manufacturer's works at the Mechanical Contractors expense and test certificates shall be submitted for all plant and equipment to be incorporated into the Contract Works. No item of equipment shall be delivered to site before the Contract Administrator has given his/her approval of the test certificate.

Where no test procedures are given, the test shall be carried out in accordance with the appropriate current British Standard and subject to the Contract Administrator's approval.

Certificates shall be included in the record documents.

3.17.3 Mechanical Contractor's Test Certificates

The Mechanical Contractor shall in accordance with the testing and commissioning section of the Specification forward to the Contract

Administrator certified copies of results obtained from testing and commissioning on completion or on sectional completion as appropriate.

Certificates shall be included in the record documents.

3.18 USE OF INSTALLATION BY CONTRACTOR

The Mechanical Contractors shall be allowed to use the installation for testing, proving, and commissioning only, and when the following requirements have been fulfilled:-

- The Mechanical Contractor has received written permission from the Contract Administrator to use the installation in accordance with the Contract Conditions and as set out in this Specification.
- The Mechanical Contractor has given written advice of the date of testing, proving and commissioning etc., to the Contract Administrator.
- The Mechanical Contractor has provided, at his/her own cost, unless stated to the contrary, all water, power, fuel, labour etc., necessary for the temporary operation of the plant including any temporary supplies for testing and commissioning.
- The Mechanical Contractor has undertaken full responsibility and arranged adequate insurance cover for the period of said operation.
- The Mechanical Contractor has arranged for a qualified and competent engineer to be in attendance on the plant and installation during the period of said operation.
- The Mechanical Contractor has given written confirmation that the running of the plant prior to handing over shall in no way affect or invalidate the Mechanical Contractor's guarantee, and Defects Liability Period which shall commence on the Certification of Practical Completion.

All costs arising from the six items listed above shall be borne by the Mechanical Contractor.

Under no circumstances shall the plant be used for any purpose other than those listed above.

3.19 EARTHED EQUIPOTENTIAL BONDING

Earthed equipotential bonding of all items of pipework, ductwork, equipment and other extraneous conductive parts shall be carried out in accordance with BS 7671 the Latest Edition of the IEE Regulations for Electrical Installations.

In order to facilitate the connection of bonding tape or cable all pipework, ductwork and items of plant and equipment shall be provided with bonding lugs. The size, location and detail of all bonding lugs shall be incorporated on to the Shop Drawings.

In general bonding lugs shall be provided at the following locations:-

- On all incoming gas, water and other services.

- On all pipework over 25 mm nominal bore within plant rooms and distribution ducts and risers.
- On all ductwork within plant rooms and distribution ducts and risers.
- At each side of any pipework or ductwork non-metallic joint or flexible connection, whether or not fitted with tie bars.
- On all non-electrical items of plant and equipment, e.g. tanks, cylinders, calorifiers, boilers, pressure vessels, flues, air handling units.

3.20 SUITABILITY OF MATERIALS AND PRODUCTS

Use material and products which:-

are new unless specified otherwise are suitable for the services and conditions of use normally expected to apply after the installation is complete;

are able to withstand the testing and commissioning conditions specified;

do not initiate mould growth, support vermin, contain animal hair, contain crocidolite or support bacterial life;

do not involve the use of CFC's and HCFC's at any stage of manufacture, installation or subsequent operation except where specified;

are free from objectionable odours at the maximum or normal working conditions of operation;

do not suffer deterioration at the maximum or specified conditions of operation;

are capable of being applied to a base surface without causing damage or deterioration of the base;

are not a fire hazard, and do not evolve dense or toxic fumes when subjected to excessive heat, such as a fire;

when of similar type, are made by the same manufacturer;

whenever possible ensure products are manufactured and/or stocked under one of the following:

- BSI Kite Mark Scheme
- BSI Safety Mark Scheme
- From Firms of Assessed Capability to BS 5750
- From Stockists of Assessed Capability to BS 5750

No materials generally known to be deleterious are to be used in, or incorporated into, any temporary or permanent part of the Works.

In particular use none of the following:-

- Asbestos Products
- Urea Formaldehyde

Check with manufacturers and/or suppliers of products and material that products contain no such deleterious materials. If any specified product contains such material request an alternative specification of product, manufacturer or supplier

3.21 HANDLING

Offload and transport about the Works all materials and product as recommended by manufacturers.

3.22 STORAGE

Store all material and products as recommended by manufacturers.

Provide sufficient, safe and secure storage for all materials and products.

Provide racks to prevent distortion for storage of conduits, pipes and similar materials.

Store all fittings, accessories and sundry items in clean bins or bagged and stowed in racks and maintained under suitable weatherproof cover.

3.23 PROTECTION OF CONTRACT WORKS

Where the Main Contractor provides protection the Mechanical Contractor shall check regularly the protection provided after installation of equipment and inform the Main Contractor if inadequate.

Install items such as grilles, diffusers, lighting fittings, switches accessories etc. as near to completion as practicable.

Only install filter media when the plant items concerned are being commissioned and tested.

Leave plant and equipment in a ready to paint condition where specified as part of the Works or to be carried out by others.

Paint parts liable to corrosion immediately after removal of any temporary protection.

Replace material, plant or equipment where deterioration or damage has occurred prior to handover.

Where the Mechanical Contractor provides protection he/she shall provide adequate and safe protection for all material and products after installation.

Ensure all items are protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others.

3.24 ROOM TERMINAL LOCATIONS

The positions of all connection points, accessories, apparatus, equipment and other room terminals shown on the tender drawings are approximate and for guidance in the preparation of the tender.

Include for the determination on site, in collaboration with the Engineer and Mechanical Contractor, of the finalised position of all such terminals.

Allow for the movement of all such terminals up to a radius of 2.0 m from the positions shown on the drawings.

Mounting heights indicated in tender documents are for tender purposes only. Confirm mounting heights with the Engineer before commencing work on site.

3.25 MAINTENANCE OF EXISTING SERVICES

Fully maintain all existing services to existing premises during the progress of the Works.

Fully maintain the services to existing premises during the progress of the Works as listed in the "Specific Details" section.

Provide any additional work and materials necessary to maintain these services at all times during the duration of the Contract.

Any existing services disturbed by the Works are to be reinstated fully in accordance with the standards of quality defined in the specification and to the satisfaction of the Contract Administrator.

Make all connections to existing services out of normal working hours.

3.26 IDENTIFICATION OF PLANT AND EQUIPMENT

The Mechanical Contractor shall include for the complete identification of all plant and equipment etc., with white traffolyte labels having black lettering in general or red lettering where indicative of danger, risk or 400V, to a size, position and description as specified by the Contract Administrator.

The labels shall be fixed by chrome plated round headed screws where on a flat surface, or chromium plated "figure of eight" label attachments where secured to uneven objects such as valves, etc.

All fused connection units, double pole switch accessories and any other accessories which are required under this specification, shall be engraved.

The accessory plate shall be engraved in either black or red, capital letters 5mm high detailing the appliance or equipment being supplied by the accessory.

3.27 CLEANING OF MATERIALS AND WORKS

The Mechanical Contractor shall thoroughly clean out the interior of each item of the installation and plant immediately after the execution of any work on that item, to the satisfaction of the Contract Administrator.

Immediately prior to Practical Completion of the Contract Works, the Mechanical Contractor shall thoroughly clean down the works in an approved manner, and ensure the installation, including all plant, is free from dust, dirt, moisture and other foreign matter.

3.28 TESTING AND COMMISSIONING OF SERVICES

Agree with the Main Contractor a programme for pre-commissioning checks, setting to work, commissioning and performance testing, and allow for all costs incurred.

Give not less than fourteen working days notice to the Main Contractor and Engineer and state any requirements for the attendance and co-operation of others.

Provide all necessary facilities to enable test to be witnessed and inspections carried out either on site or at manufacturer's works.

The Engineer will only witness test proceedings, confirm recorded results and determine if the specified requirements have been satisfied. If following test or inspection any plant or part thereof is shown to be defective or not conforming to the specification, the Engineer will reject such defective parts by written notice, within reasonable time, indicating area of dispute.

Appoint an "approved" engineer, to supervise the whole of the testing, commissioning, performance testing and instruction of client's staff.

Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities.

Test all equipment, material and systems as detailed in Works Sections. If an inspection or test fails, repeat the procedure, until satisfactory results are obtained.

Complete all tests before any paint, cladding or similar material are applied or before services are concealed.

Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning.

Following satisfactory completion of testing and when the installations are in a safe and satisfactory condition, set to work, regulate and adjust, as necessary, to meet the specified design requirements.

Provide all necessary instruments and recorders to monitor systems during commissioning and performance testing.

Do not start performance testing, including system demonstration, system proving or environmental and capacity testing, until commissioning of the system is completed to the satisfaction of the Engineer.

Maintain on site full records of all commissioning and performance testing, cross referenced to system components and on completion of the Works include a copy in each Operating and Maintenance Manual.

Provide all certification documents for approval by the Engineer before any system is offered for final acceptance.

Gas, fuel oil, electricity and water for testing and commissioning will be provided as detailed in the Main Contract Documents.

3.29 RECORD DOCUMENTS

Two weeks prior to Practical Completion, in addition to the requirements of the Preliminaries Document, the Mechanical Contractor shall provide to the Contract Administrator for distribution two approved sets of the bound record documents comprising Record Drawings and Operating and Maintenance Manuals as described below, together with:-

Two sets of top quality paper prints of the Record Drawings.

In addition, at Practical Completion the Mechanical Contractor shall provide one further set of prints together with two complete sets of Autocad disk files (Latest Edition) and PDF files to the Clients Specification.

The Record Documents shall comprise the following:-

3.29.1 Record Drawings

As defined earlier in this section.

This document shall provide a concise overview of the installations with the key information only on main isolation points, emergency stops and main maintenance items.

Electrical drawings shall be in accordance with IEE Regulations, latest edition.

3.29.2 Full Operating and Maintenance Instructions

The Mechanical Contractor shall provide a manual(s) to include all operating and maintenance instructions containing all information to enable the Client to operate and maintain the installations and equipment, comprising fully detailed sections including the following.

The arrangement of service manuals shall be prepared by the Mechanical Contractor in the following manner:-

Section 1	Index
Section 2 Equipment	Full Description of the Design Intent, Systems and
Section 3	Emergency Measures and fault finding techniques
Section 4	Schedule of routine and periodic maintenance.
Section 5	Manufacturer's Literature including list of standard replacement parts and operating instructions
Section 6	Equipment Schedules including manufacturers works/references numbers and contact details
Section 7	Testing & Commissioning Certificates
Section 8	'As Installed' Drawings

The documents shall be bound in stiff-backed ring binders and shall be A4 size, finished in black welded PVC with "pull open" two ring fitting at 80mm centres and of a capacity to suit the intended contents.

All the contents shall be mounted in clear PVC pockets sealed on three sides, open at the top and punched at 80mm centres.

The Contractor shall also provide an electronic PDF format copy. Within the electronic document each of the 8 N^o sections, detailed above, shall be booked marked and hyperlinked to the contents list at section 1.

The Mechanical Contractor shall include for all costs and expenses in this context and shall indicate the item separately in his/her Tender Summary.

The documents shall only include information relevant to the installations and shall not include other equipment or instructions in other languages.

In the event of the Mechanical Contractor failing to comply with this Clause in the stipulated time for production etc., the Contract Administrator shall have the power to recommend the Contract Works as being unacceptable to hand over due to insufficient information being available to enable the plant to be operated and maintained in accordance with the Health and Safety at Work Act, and furthermore shall have the power to instruct the work to be carried out by others and deduct the resultant costs from the Contractors Final Account.

3.29.3 Building Log Book

To comply with Building Regulations the Mechanical Contractor shall provide a building log book using CIBSE TM31 main template. The log book is intended to provide the building owner with the details of installed building services plant and controls, their method of operation and maintenance, and other details that collectively enable energy consumption to be monitored and controlled.

One paper copy and one electronic copy shall be handed to the client upon completion of the project.

3.29.4 Manufacturers Test Certificates

As defined earlier.

3.29.5 Contractors Test and Commissioning Certificates

As defined earlier.

3.30 TRAINING OF CLIENT STAFF

The Mechanical Contractor shall allow for the Person in Charge to instruct the Client's staff in operating, maintaining and servicing the entire plant. The Contract Administrator will give seven days written notice of his/her requirements for this period of instruction to commence.

The Mechanical Contractor shall allow for instructions on specialist equipment or systems to be given by the manufacturers/suppliers.

3.31 DEFECTS LIABILITY PERIOD

The Mechanical Contractor shall be responsible for the repair/replacement of items installed under this contract which due to faults of materials or workmanship fail to provide satisfactory service during the 12 month period (unless defined otherwise in the Main Contract documentation) following the date of practical completion.

SECTION 4

PIPED SERVICES

4.1 WATER SUPPLY BYE-LAWS

Water installations and all components shall comply fully with the current version of the Water Supply Bye-Laws applicable for the locality of the installation.

All systems and components shall comply fully with the current edition of the British Standard and British Standard Code of Practice where applicable. Where no British Standard is applicable the systems and components shall comply with the relevant Water Research Centre Specification and water fittings which have passed the WRC test for compliance with the bye-laws shall be used in preference to others.

4.2 INSTALLATION OF PIPE SERVICES GENERALLY

4.2.1 Internal

Installation of all pipework shall follow the details set out in the Installation Drawings, and be in accordance with the best accepted practice.

Details set out in the following Clauses of this section are generally appropriate to all services except where specifically stated.

All pipework shall be adequately supported on hangers or on brackets with rollers, according to position, in order to permit free movement due to expansion and contraction and the amount of such movement shall be proportioned throughout the system by the provision of anchors at suitable points. All pipework shall be arranged to accommodate without distortion the linear expansion when heated. Pipe supports shall be of the type which will allow full movement of the pipes except at fixed locations which shall be provided as necessary between expansion points. The fixed locations shall be secured by anchors of approved design.

Pipes shall be spaced in relation to one another and to the building structure so as not to interfere with any other services and to allow for the required method and thickness of thermal insulation as specified.

Clearance between pipework or pipework insulation and finished walls, floors, ceilings and other fixtures should be adequate for cleaning purposes, future dismantling etc., and shall not be less than the distance given below:-

Pipework to pipework minimum distance	25 mm.
Pipework to floors minimum distance	150 mm.
Pipework to ceilings minimum distance	50 mm.
Pipework to walls minimum distance	25 mm.

All exposed pipe runs shall be arranged to present a neat appearance and where practicable be parallel both with one another and with the building structure taking due regard however to the grading, venting and draining requirements. All vertical pipes shall be plumb. All pipe runs shall be arranged so that the longest length of tube practicable is used between bends, tees and flanges or unions. Short lengths of tube joined together by sockets or flanges shall not be employed.

To facilitate routine maintenance the positions of all valves, drains and supports shall be determined with this aspect in mind. Grouping of valves, drains, unions, flanges etc., shall be preferred to scattered siting. All pipework, valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement. In this context "accessible" means that the provision for dismantling the flange, union etc., can be reached and worked upon either in the open or else by removal of a purpose made duct cover, manhole or similar cover. The fitting is not accessible if, as fixed, it cannot be manipulated. No pipe shall be installed without a flange or union at a point where it passes through a wall, floor or ceiling and is not readily removable. No joints shall be formed within the thickness of walls, floors or ceilings. Unions or flanges shall be provided generally at a maximum spacing of one per twelve metres, in agreed positions.

Where pipework is buried, embedded in a floor duct or any other situation where it is not completely accessible for regular inspection of the whole of each joint, e.g. above false ceilings, in main riser positions or other limited access riser ducts, it shall have welded joints and fittings.

On concealed pipework, if screwed joints to air vents, drain cocks and pressure gauges are used then full access shall be provided to allow complete inspection, dismantling, removal, replacement and re-jointing.

Pipes shall be bent around piers and all other projections and recesses and for all off-sets due to varying thicknesses of plaster, walls, floors, ceilings and other structural works. Due allowance shall be made in all cases for obtaining full details relating to the skirting heights, sill heights and floor finishes.

No pipework off-sets shall be allowed on pipework visible in rooms except by prior agreement. Purpose made fittings shall be employed at all times unless it is impractical and prior approval has been obtained to form bends etc. Bends, springs and off-sets shall be formed by use of an efficient bending machine. Fire sets shall not be employed. Copper tube may have its bends, springs and off-sets formed with springs or a bending machine. All changes of direction formed shall be made with a minimum of loss of local wall thickness. The diameter shall be maintained. Crinkled and scored work will be rejected.

All cuts from standard lengths of pipe shall have all burr and swarf removed, the ends shall be trimmed square and shall be thoroughly cleaned before erection. The right is reserved to instruct the cutting open of any 10 (ten) sections of pipework for inspection. If the result suggests that the standard of workmanship on the whole, of the rest of the installation, is below that required, the right is reserved to instruct the removal of the remainder of the installation in whole or in part, and to have sections renewed to conform with this Specification. In this case, there shall be no claim allowed for the costs

involved in removing and renewing these sections of the Works, whether such work is found to be faulty or not.

Where pipes are held in vices, as when screwing or cutting, care shall be taken to ensure that the pipe surface is not damaged. Wrench marks on the beads of malleable fittings, valve flats or any other components will not be accepted. Any pipework or fittings so damaged shall not be fitted.

Due allowance shall be made to protect the open ends of all pipework. Suitable caps, plugs or plastic covers only, shall be used to cover open ends. Wood, rag or paper plugs shall not be used. Valves fitted to the open ends of tubes or pipes shall not be used to prevent the entry of dirt. The right is reserved to order the pipework to be dismantled for as far as considered necessary and the pipework to be cleaned internally should the above requirements not be observed. This work shall be carried out free of cost to the Employer including the removing, cleaning and replacing of the sections of pipework.

4.1.2 Underground Pipework - Cold Water and Gas

Gas pipework installed underground shall be carried out by an approved Specialist Contractor using medium density polyethylene (MDPE) pipework and fittings conforming to British Gas Council Standard BGC/PS/PL2 Parts 1 and 2. Installation shall be carried out in accordance with British Gas recommendations.

Cold water pipework installed underground shall be carried out using one of the following:-

- Medium density polyethylene (MDPE) pipework up to 63 mm to BS 6572 (WRC Specification 4-32-02) with fittings to WRC Specification 4-32-04, jointed using butt fusion.
- MDPE pipework above 63 mm to WRC Specification 4-32-03 with fittings and joints to WRC Specification 4-32-04.
- Copper pipework to BS 2871, Part 1, Table 'Y' jointed using fittings to BS 864 Part 2. Compression fittings shall be of type 'B'.
- Ductile iron concrete lined to BS 4772 Class 'C'.
- Centrifugally cast (spun) iron pipes to BS 1211 Class 'C' with spigot and socket joints and fittings to BS 78, Part 2.

All copper and iron pipework underground shall be wrapped with bituminous hessian painted with two coats of bitumen, alternatively copper pipework may be plastic covered.

Plastic pipework shall be installed in accordance with British Standard Code of Practice CP 312.

4.3 PIPEWORK MATERIALS

All pipework and tubing used in the construction of the various plants described in this Specification shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, laminations and other defects and shall be free from rust and scale.

Standard steel pipes having nominal bore of up to 125 mm shall be provided in random lengths of between 4 m and 7 m and shall be manufactured to BS 1387.

All steel pipework shall be to the 'Medium' grade of BS 1387 except for the following, which shall be 'Heavy' grade:-

- All chilled water pipework.
- Screwed pipework in the 20 mm and 40 mm sizes.
- Pipework which is permanently concealed, i.e. built in chases, ducts, partitions, ceiling voids and floors.
- Pipework risers over 20 m high.
- Underground pipework.

Steel pipework over 125 mm bore shall be of black mild steel manufactured in accordance with BS 3601 (not butt welded). The wall thickness and outside diameters shall be:-

- 150 mm diameter 5.4 mm thick 165 mm OD
- 174 mm diameter 6.3 mm thick 194 mm OD
- 200 mm diameter 6.3 mm thick 219 mm OD
- 250 mm diameter 6.3 mm thick 273 mm OD
- 300 mm diameter 7.1 mm thick 324 mm OD
- 350 mm diameter 10.0 mm thick 356 mm OD

Steel pipes shall be varnished externally throughout their length after manufacture. Light gauge copper tube shall be used where specified and all tubes shall be solid drawn from phosphorous de-oxidised non-arsenical copper to BS 6017 free from any deleterious film.

Copper tube shall be Half Hard Temper, complying with the requirements of BS 2871 Part 1, Table 'X'.

The materials for piped services shall be in accordance with the following table and clauses in this Section and shall not be varied without prior written permission.

Service	Bore	Material
LTHW	All	Black mild steel
Heating Open Vent	All	Galvanised mild steel
Heating cold water feed	All	Light gauge copper
Steam	All	Black mild steel
Condensate	All	Copper tubes to BS 2871 Pt 2

Note: Condensate pipework shall be deemed to start at the outlet of each trap and pipework to the appropriate working pressure table in BS 2871 Pt 2 shall be used.

Service	Bore	Material
Chilled Water	All	Black mild steel
Domestic Hot & Cold Water Services	Up to 150 mm dia.	Light gauge copper
Natural Gas	Up to 150 mm dia.	Black mild steel Alternatively 15 mm to 50 mm in light gauge copper
Hose Reels above ground	Up to 54 mm dia.	Copper tubes with fittings to BS 864
Refrigeration Pipework (Not Ammonia)	Up to 100 mm dia.	Refrigeration standard Hydraulic copper tube.
Refer to Separate Clause		

4.4 METHODS OF JOINTING

Pipework shall be jointed as shown in the table below unless otherwise indicated in the Specification or on the drawing.

In addition to those places indicated, screwed joints shall be used where the act of welding would constitute a fire hazard over and above the normal accepted level, but only when approved in writing.

Pipework shall have the following joints used to facilitate removal:-

- Unions on welded or screwed steel pipework up to 50 mm nominal bore.
- Flanges on welded or screwed steel pipework above 50 mm nominal bore.
- Unions on copper pipework up to 65 mm nominal bore.
- Flanges on copper pipework above 65 mm nominal bore.

Plant rooms, underground ducts, trenches, ceiling voids, electrical switch rooms, computer rooms, telecommunications rooms, control gear rooms etc., and all inaccessible places.

Service	Nominal Flange Pressure Rating Bar	Material	Bore	Method of Jointing
Low Temperature Hot Water	10	Black MS	All sizes	Welded throughout
Natural Gas	6	Black MS	All sizes	Welded throughout
		Copper	13-50 mm	Capillary fittings
		MDPE		Butt fusion
Oil Lines	6	Black MS	All sizes	Welded throughout
		Copper	15-50 mm	Securex Compression Fittings

Domestic Hot and Cold Water		Copper	All sizes	Capillary fittings
Hose Reels	10	Copper	All sizes	Capillary fittings
Steam	25	Black M S	All sizes	Welded
Refrigeration Lines		Copper	All sizes	Brazing fittings
Condensate Lines		Copper	All sizes	Securex compression fittings

In rooms where generally on view:-

Service	Nominal Flange Pressure Rating Bar	Material	Bore	Method of Jointing
LTHW	10	Black MS	Up to 50 mm	Screwed
Chilled Water	10	Black MS	Up to 50 mm	Screwed
			Over 50 mm	Welded
Natural Gas	6	Black MS	All sizes	Welded
		Copper	15-50 mm	Capillary fittings
Oil Lines	6	Black MS	All sizes	Welded
		Copper	15-50 mm	Securex Compression fittings
Domestic Hot and Cold Water		Copper	All sizes	Capillary fittings
Hose Reels	10	Copper	All sizes	Capillary fittings

Steam	25	Black MS	All sizes	Welded
Refrigeration Lines		Copper	All sizes	Brazing fittings
Condensate compressor		Copper	All sizes	Securex fittings

4.5 SCREWED JOINTS

Screwed joints on steel pipework shall be in accordance with BS 21.

Steel pipe having screwed joints shall be carefully reamed out before the plain end is screwed.

When making a joint the screw thread shall be coated with a white compound to BS 5292 and hemp, all surplus jointing compound being finally cleaned off to leave a surface suitable for painting. P.T.F.E. tape may only be used with prior approval. The joint shall be arranged so that on completion two or three threads are left showing.

Should a screwed joint prove defective under subsequent test, the section of pipework in question shall be removed and made good. Caulking will not be permitted.

4.6 WELDED JOINTS

Steel pipe having welded joints shall be prepared for jointing in a manner suitable for the technique employed. Welds shall be carried out in accordance with BS 2971 for metal arc-welded joints and BS 2640 for oxy-acetylene welded joints.

Pipes shall be prepared for welding with ends sawn or cut off by hand, flame cut by machine or flame cut by hand with subsequent truing up by filing or by grinding to a level of 37.5° as may be required. Welding rods shall in all cases be of good quality copper coated low carbon steel and the manufacturers shall provide test certificates representative of the rods used.

Welding shall in all cases be carried out by skilled craftsmen who are in possession of a current certificate of competency issued by an approved authority (which shall be produced upon request) and have had a suitable period of experience for the class of work in which they are engaged.

Each welder shall be assigned a reference which shall be stamped on each weld and when the general hydraulic tests of the completed systems are carried out, as detailed elsewhere, each weld shall be lightly hammered during the time that pressure is maintained. If any leaks occur at welds the portion of the weld near the leak shall not be repaired by caulking or attempted fusion of the surrounding metal. Should a considerable portion of the welded joints made by a particular operator be found to be defective due to faulty workmanship, all such welds shall be cut out and re-welded by another operator whose work has proved satisfactory.

During the progress of the Works, inspection will be made to ensure the quality of welding. The right is reserved to instruct the cutting open of up to any 10 (ten) sections of pipework which include welded joints and to have these parts laboratory tested. If the inspection and test show that the welds are below the class of workmanship for this

class of work, or if they are found to be faulty in any respect, no cost or fees incurred by the tests shall be borne by the Employer.

If this result suggests that the standard of workmanship on the whole of the rest of the welded work is below the required, the right is reserved to instruct the removal of the remainder of the welded sections in whole or in part, and have these sections renewed to conform with this Specification. In this case, no claim for the costs involved in removing and renewing these sections of the Works shall be allowed, whether such welds are found to be faulty or not.

During all welding or cutting operations, the welder shall be accompanied by a competent assistant and suitable fire resistant mats shall be used to protect the building fabric and decorations. Every precaution shall be taken to prevent damage by scorching or fire and two portable fire extinguishers shall be provided for use by the welders in an emergency.

After cutting or welding, all scale shall be removed from all pipework before erection, and all welded joints including internal faces, ie. flange joints, shall be painted two coats of red lead oxide on completion of the joint.

Inspection of all welding on site and/or at manufacturers works and the witness of all hydraulic tests shall be made by the Clients Insurance Company and the payment of all inspection fees shall be included.

All welding shall comply in every respect with the standards required by the Clients insurers and the operatives shall carry out test welds if requested by the Clients insurers.

4.7 FLANGED JOINTS

Steel pipes shall have flanged joints to BS 4504 Part 3 and shall be prepared to suit the method of attachment required. Flange pressure ratings shall be to the minimum set out in Clause 4.4 and to suit the particular pipeline fitting or equipment.

Pipes not galvanised shall be provided with flanges screwed or welded on for nominal bores of 50 mm and below with flanges welded on for larger sizes. Galvanised pipes shall be provided with galvanised flanges screwed for nominal bores of 100 mm and below, and with flanges welded on prior to galvanising the pipe for larger sizes, or where specified for all sizes galvanised after manufacture.

Where flanges are secured by screwing, the threads on the tube shall be arranged to end at a point just inside the bore of the flange, so as not to interfere with the joint. After the flange has been screwed on, the tube shall be expanded into the flange by a roller expander.

Welded flanges shall be of the slip-on pattern with neck machined on face secured by welding both the neck and bore of the flange to the pipe, with the tube finishing 3 mm inside the bore. Care shall be taken not to distort the machined face.

Flanges shall be joined with 1.6 mm 'full faced' Klingerite gasket with bolts nuts and washers of hexagon type. Bolts for BS 4504 flanges shall be to BS 4190, 400 N/mm² minimum tensile strength. The gaskets will have graphite finish and no jointing paste will be used. All flange bolts shall protrude two threads clear of the nut.

Copper pipework shall have flanged joints to BS 4504 Part 3 bronze welded to BS 1724.

4.8 COPPER PIPEWORK JOINTS

All jointing of copper tubes shall be strictly in accordance with the fitting manufacturers recommendations.

Where capillary fittings are used, care shall be taken to ensure that the solder used is suitable for the temperature conditions of the system.

All jointing materials shall be manufactured from non-dezincifiable materials.

All solder droppings and surplus flux shall be removed on completion of the joint.

During all jointing operations using capillary welded and brazing fittings, the fitter/plumber shall be accompanied by a competent assistant and suitable fireproof mats shall be used to protect the building fabric and decoration. Every precaution shall be taken to prevent damage by scorching or fire and two portable fire extinguishers shall be provided for use by the fitters/plumbers in an emergency.

All fittings and jointing materials shall be suitable for the temperature and pressure of the system. Brazing and bronze welding shall be carried out in accordance with BS 1723, BS 1724 and the Code of Practice for Brazing and Bronze Welding of Copper Pipework issued by the HVCA.

The manufacturers recommendations for materials and jointing shall be followed in respect of chemical injection systems used for water treatment.

4.9 FITTINGS FOR MILD STEEL PIPEWORK

Screwed tees, bends and springs for use with standard steel pipes shall be to BS 1387 'heavy' grade. Ends shall be provided with screwed taper threads to BS 21.

Malleable cast iron pipe fittings shall be to BS 143 and 1256, manufactured by the Whiteheart process to BS 6681, banded or beaded for reinforcement.

Wrought steel pipe fittings shall be manufactured from mild steel by a seamless or welded process to BS 1740, 'Heavy' grade.

The screwed ends of the fittings shall be provided with parallel female and taper male threads to BS 21, the axis of threads being coincident with the true axis of the fittings. Where specified, threaded fittings shall be provided and shall be in accordance with BS 143.

Unions shall be manufactured with double gunmetal seats as the 'Navy' pattern, and must be positioned where accessible so that they may be sprung apart.

Welding fittings shall be to BS 1965 : Part 1 for steel tube to BS 1387 and be manufactured by a forged seamless process from mild steel, 'Heavy' grade.

For tube to BS 3601 fittings shall be as follows:-

<u>Nominal Size</u>	<u>Wall Thickness</u>	<u>Outside Dia.</u>
150	5.4 mm	165 mm
175	6.3 mm	194 mm
200	6.3 mm	219 mm
250	6.3 mm	273 mm
300	7.1 mm	324 mm
350	10.1 mm	356 mm

Ends of fittings, which shall have where possible the same bore and the same wall thickness as that of tube to which they are to be connected shall be bevelled for butt welding.

All bends where practicable shall be formed in the pipe run (ie. made bends). Where standard welded fittings are used they shall be of the same quality as the pipe and shall conform the BS 1965 : Part 1.

Bends shall be 90° long radius type unless space for pipework is restricted in which case the short radius welding elbow may be used subject to prior written approval. Cutting and shutting will not be permitted.

All changes in direction shall be proportioned so that the ratio between the centre line radius of the bend and the inside diameter of the pipe is not less than 1.5 to 1.

If bends and springs are formed on site, then cold bending by a hydraulically operated machine will be permitted for standard steel pipes having bore of 50 mm and less but larger pipes shall be bent hot. All bends shall be normalised by heat treatment after manipulation.

All sets, double sets and springs shall be formed from long lengths of tube with as large a radius as possible and shall be free from distortion.

Branch welding fittings shall be used where the branch is 25 mm diameter and above. From branch sizes below 25 mm the sweep may be formed from pipework. Where junctions to steel mains are formed by factory or site welding, such work shall be carried out to conform to BS 806. All necessary reinforcement by way of plates, collars or shoes shall be provided. All branch tees where possible shall be formed by the use of special welded fittings of the same quality as the pipe and shall conform to BS 1965 : Part 1.

Where branch bends are used in lieu of manufactured tees, the profile of the hole shall be removed from the main before the branch is welded into position. Branch bends may only be used where the branch is two or more sizes below the line size. The distance between the centre of two adjacent branch welds shall not be less than twice the diameter of the large branch.

Where practicable all fittings shall be of the easy sweep type. Branches shall be made using swept tees or branch bends except where an air lock is liable to form, i.e. tees on rising mains etc., where square tees shall be used.

Where standard fittings are not available for the duty required, reductions on the run and to the branch shall, in all cases, be made with reducing sockets, not bushes.

Reducing fittings on horizontal pipework shall be of the eccentric pattern fixed so as to give a smooth run to the crown of the pipe. Concentric pattern reducers shall be used on vertical pipework.

4.10 FITTINGS FOR COPPER PIPEWORK

Capillary and compression fittings shall be to BS 864 : Part 2. All fittings shall be manufactured from materials being non-dezincifiable. Any fittings not in keeping with this requirement shall be replaced at no cost to the Employer.

Manufactured fittings shall be used where the pipework is on view, a mixture of fittings and pulled bends is not permitted. All branch connections shall be by purpose made tees either square or sweep to suit the application.

Where practical, fittings shall be of long sweep pattern. Where standard fittings are not available for the duty and sizes required, reductions shall be made with purpose made fittings.

Where light gauge copper tubes are pulled on site to form bends and offsets, the materials used shall be as for adjacent straight lengths. Tubes having nominal bores up to 28 mm may be bent cold but larger sizes shall be annealed before manipulation.

In all cases, tubes shall be loaded prior to bending with springs, low melting point alloys or an inert sand, care being taken that contamination of the tube material is avoided. Where bending machines are used these shall have smooth clean guides and formers, any scored or damaged tools being rejected. Pulled bends with any deformity whatsoever resulting in the forming of the bend will not be accepted.

Where it is intended to use compression fittings on underground pipework, this shall only be allowed following prior approval and the fittings shall be of the type 'B' pattern.

Unions shall be manufactured from gunmetal and shall be in accordance with BS 864 : Part 2.

All fittings and jointing materials are to be suitable for the working temperature and pressure of the system.

The manufacturers recommendations for materials and jointing on chemical injection systems used for water treatment shall be strictly followed.

4.11 SUPPORTS AND FIXINGS

All pipework shall be properly supported and bracketed and must permit, where required, adequate free and/or guided movement due to the operating conditions applicable.

Particular importance must be made to the type of supports and brackets for pipework and associated equipment. The materials, construction, method of fixing, practicability and appearance of the brackets must be carefully considered.

Full and proper care shall be exercised in the positioning and marking out of all brackets and supports. Brackets and supports shall be set out so that they do not obstruct the access to valves, flanges or fittings requiring maintenance.

Generally pipes shall not be supported from each other but where this is considered necessary and written permission has been given, this may occur. The brackets so installed shall not prevent the removal of any individual pipe where necessary and provision shall be made for unequal expansion where applicable.

Pipes shall not be supported from any items of equipment.

All pipes exposed to view and generally around rooms at floor level shall be supported on schoolboard pattern long shank build-in or screw-on brackets.

Pipe brackets on exposed copper pipework shall be of the cast brass type. Under no circumstances will brass strip or copper strip type brackets be acceptable.

Brackets on insulated pipework, incorporating a vapour seal shall be fitted with spacers and sleeves at the time of installation of the brackets using an approved material between the bracket and pipe surface to achieve satisfactory vapour sealing. Materials for supporting and fixing the various items of piping, tubing etc., are detailed in Section 6. It shall however, be a firm principle of all fixing that the contact of dissimilar metals must be avoided and to this end steel piping shall have steel supporting members actually in contact with the pipe, galvanised piping shall have galvanised contacts and copper tubing shall be carried exclusively from contact members constructed from copper alloy, or where mild steel clamp saddles are used, a lead lining interposed. All spring washers, shakeproof items, lock nuts etc., shall be included.

Structural steelwork shall not be drilled either for the passage of pipes or the attachment of brackets, nor shall steelwork be welded to, without written permission.

In all positions throughout the building all necessary supports and brackets complete with all bolts, screws and insert or plug fastenings shall be provided. Softwood plugs will not be permitted.

All fastenings and fixings to the constructional and fabric elements of the building shall be included. All methods of fixing, and fastening shall be purpose designed and approved. Direct fixing, self-drilling and normal drilling methods of fixing to in-situ concrete slabs will be considered for approval.

No fixings whatsoever will be allowed into any external cladding panels or to the inside of any double skin roof decking. All supports in the latter instance shall be taken from the purlins.

On precast, prestressed and hollow floor constructions, metal plate and rod hanger supports with associated drilling of the structure and secondary spanning steelwork shall be employed subject to written approval.

In certain areas "Holorib" decks are provided containing dovetail slots which may be used in conjunction with "Holowedges" for all necessary fixing. Except where otherwise indicated all necessary secondary support steelwork to provide fixings other than at the slot locations shall be provided and installed by the Contractor.

On hollow wall construction and light partitions, fixing of the spring clip or toggle type shall be used. On extremely light partitions, the pipes may be supported from the floor but approval must be obtained.

Main walls and partition walls etc., where pipes pass through sleeves, shall not be considered as pipe supports.

The spacing of the supports shall conform to those given in the table below and the distance shall not be exceeded.

Steel Pipework			Copper Pipework		
Bore (mm)	Horizontal (m)	Vertical (mm)	Diam (mm)	Horizontal (m)	Vertical
15	2.0	2.4	15	1.4	1.8
20	2.4	2.7	22	1.4	1.8
25	2.7	3.0	28	1.7	2.1
32	2.7	3.0	35	1.7	2.1
40	3.0	3.6	42	2.0	2.4
50	3.4	3.6	54	2.0	2.4
65	3.7	4.2	67	2.0	2.4
80	3.7	4.2	76	2.4	2.7
100	4.1	4.8	108	2.7	3.3
125	4.4	5.5	133	3.0	3.6
150	4.8	5.5	159	3.0	3.6
200	5.1	6.0			
250	5.8	6.0			
300	6.0	6.0			

In addition to the centres given above, supports shall be provided adjacent to all valves, flanged joints and other special components to prevent undue strain on the adjoining pipework and so that the components or sections of pipework may be removed, leaving the adjoining pipework adequately supported at the ends.

Vertical pipework shall be suitably supported at the base of the riser and at all intermediate levels. Branch circuit pipes shall not be used as a means of support for the riser main.

Written approval must be obtained of the type of brackets proposed prior to commencing manufacture of any brackets.

Pre-fabricated brackets, anchor points, guides and clamps shall conform generally to the details in BS 3974 Part 1 and Part 2.

4.12 PIPE SLEEVES

In all cases where pipes pass through walls, floors, ceilings and footings, sleeves shall be provided and it shall be ensured that the sleeves are correctly built-in. Sleeves shall in no case be used as pipe supports, a free annular space always being provided. Puddle flanges shall be provided on pipework passing through walls and intended to be covered by earth etc., or where passing through bund walls. Sleeves shall be of pipe cuttings properly reamed, cleaned and trimmed at 90° to bore.

Sleeves in load-bearing walls or footings shall be cast iron pipe. sleeves in non-load bearing walls, floors, ceiling and partitions shall be in copper or mild steel or high impact plastic to suit the particular pipe material.

Pipework, sleeves and fire-stopping shall be installed to meet the requirements of the current Building Regulations to the approval of the Building Inspector.

Flashing sleeves shall be provided as required except where indicated otherwise. They shall incorporate an integral flange to which a flashing shield can be clamped or welded. The shield will be built into the membranes and the space between the sleeve and pipe shall be filled with mineral wool fire stopping and finished externally with intumescent mastic compound.

Inside diameter of sleeves shall be not less than 12 mm larger than the outside diameter of the pipe, except where pipes pass through load-bearing walls or footings where sleeves shall be 100 mm larger than the outside diameter of the pipe.

For pipes which change direction over size sleeves, the size larger than normal, shall be fitted to allow for expansion.

The space between the pipe enclosed and its sleeve shall be caulked with fire stop and intumescent mastic seal on each side of the sleeve. Alternatively a proprietary sealing system shall be used which has been shown by test to maintain the fire resistance of the structure and which has been approved by the Building Inspector.

Sleeves shall not protrude from the finished face of walls. In kitchens and all other situations where the floor may be swilled, the sleeves shall project 30 mm above the finished floor level.

Chilled water pipework and cold water pipework shall be provided with sleeves of such size as to allow the thermal insulation, at the full thickness, to pass through whilst maintaining the continuous vapour seal. The type of insulation shall become mineral wool with vapour seal for the thickness of wall in these instances.

4.13 FLOOR PLATES

Where exposed to view, pipes and tubes passing through walls, floors, ceilings, partitions and false ceilings of occupied rooms shall be fitted with a white plastic cover plate as manufactured by Brefco or equal and approved. Such plates shall be split on the diameter, be snug fit to the pipe concerned, and provided with securing clip or screws.

4.14 EXPANSION AND CONTRACTION

Where indicated on the drawings, provision shall be made to install expansion loops formed in the pipe runs by means of long radius welded bends to the required dimensions. The loops shall be formed in the mains with flanges and each leg of the loop shall be pulled cold to approximately 50% of the estimated expansion of the leg.

Expansion bellows and joints shall be installed in the pipework where shown on the drawing to absorb the axial movement of the pipelines. They shall be installed in accordance with BS 6129, Part 1.

Single and double expansion bellows shall be installed as indicated on the drawing or in the schedule and these shall have screwed or flanged ends as specified.

Care shall be taken when installing flanged end bellows to line up the bolt holes on joint and mating flanges and to ensure that the joint is not twisted in any way or any torsional stresses applied.

The bellows shall be installed with due allowance having been made for cold draw which will vary according to the type and length of bellow proposed and the temperature and installation. Where 'installation bars' or fittings are incorporated with the bellows during delivery and erection these must be removed before heat is applied.

The full expansion rate of the bellows and/or loop shall be as indicated on the drawings or in the Specification.

A minimum of two guide sleeves shall be fitted on each side of the expansion joint unless such joint be installed adjacent to an anchor point where guides shall be fitted on the free side only.

Guides shall consist of sleeves or framework rigidly fixed but permitting axial pipe movement while restraining the pipe from radial movement. Guides shall have a clearance of not more than 3 mm between the outer surface of the pipe and the inner surface of the guide and shall be to the following lengths:-

<u>Pipe Size</u>	<u>Length</u>
Up to 35 mm diameter	75 mm
42 mm to 133 mm diameter	130 mm
159 mm diameter and over	230 mm

Guides shall be installed not more than four pipe diameters from the expansion joint to the first guide and not more than fourteen pipe diameters between this guide and the next.

When installing manufactured expansion loops or bellow joints, the manufacturer's installation recommendations shall be observed in every respect.

When pressure testing pipework distribution it shall be ensured that the test pressure will not damage the bellows, anchor points, guides and the building structure. Where the test pressure exceeds the maximum operating pressure, temporary spacer pieces shall be installed and shall remain for the duration of the tests. Where no bellows or loops are specified, provision for expansion and contraction of pipework shall be made by changes in direction and it shall be ensured that sufficient allowance is made for this.

Branch connections are to be taken from the top or bottom of both flow and return mains depending on air venting arrangements of these. Branches shall have incorporated in them two bends before passing into sub-ducts, trenches, vertical chases etc. The bends shall be so arranged as to take up the expansion of the mains without putting any strain on the length of the branches.

4.15 ANCHOR POINTS

Where indicated on the drawings, or as required, mild steel anchors shall be installed to resist the maximum stresses of the pipework. The anchor shall be fixed to heavy steelwork or main brick walls only. The anchors shall consist of heavy section iron 'U' straps welded to the pipework and attached to the supports by nuts and bolts. Where fixed to brickwork short channel irons shall be attached to the wall to obtain a fixing for the 'U' straps.

All cleats, brackets and steelwork required for building-in shall be provided as necessary.

Details of all anchors together with loadings and associated builders work shall be submitted for approval before manufacture.

4.16 VIBRATION ISOLATION AND NOISE INSULATION OF PIPEWORK INSTALLATIONS

All dynamic machinery shall be isolated from the building structure by vibration isolators which shall be purpose designed and selected to suit the machinery. All machinery connected to pipework shall have installed vibration compensators between the plant and pipework in order to minimise the transmission of vibration and noise through the pipework.

Vibration isolators shall be as manufactured by Sound Attenuators Ltd., or equal and approved, and installed strictly in accordance with the manufacturers recommendations.

Pipework vibration compensators shall be as manufactured by Engineering Appliances Ltd., or equal and approved, and installed strictly in accordance with the manufacturers recommendations. All compensators shall be installed in accordance with BS 6129 Part 1 and shall be suitable for the pressure, temperature and chemical nature of the fluid within the service pipe to which they are installed. Due consideration must be given to the internal pressure, and expansion and contraction of the pipework

installation. Compensators shall be provided with correct mating and backing flanges and tie bolts. Compensators shall not be used to take up discrepancies in the alignment of pipework connections.

Noise and vibration level information, based upon octave band analysis, shall be submitted for all items of plant and equipment.

Supports for pipework shall include suitable isolators to limit transmission of vibration to the building structure.

4.17 AIR VENTING OF PIPEWORK

Full provisions shall be made for air venting of the systems, whether or not shown on the drawings.

All exposed air bottles, automatic vents and drip pipes where required shall be properly insulated and protected against frost.

Air vents shall be provided at all high points in the pipework. They shall be installed at the highest point of the sections which they are intended to vent.

Air bottles on pipework up to and including 80 mm bore shall be manufactured from 50 mm bore pipe, 100 mm bore and over from 100 mm bore pipe. All shall be 250 mm long with welded end caps and be complete with 8 mm copper pipe brought down from the top of the air bottle to within reach of ground floor level and fitted with 8 mm lockshield needle valve complete with key. The final vertical piece of vent pipework will be kept as short as possible.

Automatic air vents shall be used where required and shall have gunmetal bodies with not less than 15 mm connections, copper or stainless steel floats, guides and non-corrodible needle valves. In all cases the air vent shall be protected by a lockshield pattern stop valve and the discharge from the air vent shall be 12 mm copper pipe which shall be run to discharge externally or over an agreed gulley, sump or other convenient position. Automatic air vents shall be complete with check valves to prevent air ingress to the system.

On high pressure hot water pipework the vent pipework shall finish in a flanged valve complete with blank flange. Automatic air vents shall not be used.

4.18 DRAINING OF SYSTEM

Drain points shall be provided on all items of plant and equipment, at all low points of water services installations and also on the branch side of all main isolating valves and cocks whether or not shown on the drawings.

Drain points shall be fitted with a drain cock of gunmetal construction manufactured to the requirements of BS 2879 : Table 'A' complete with hose union and removable key.

On high pressure hot water pipework the drain point shall finish in a flanged valve complete with blank flange.

Any equipment or component supplied within the terms of the Contract which are fitted with condensate trays, drains, overflows or discharge collection points, shall be provided with drain pipes extended to the nearest gulley or drain, by an approved route. Condensate drip trays shall be provided with a water seal trap of depth not less

than twice the duct static pressure, on the outlet prior to the tundish. All drains which discharge into a drainage pipe or stack shall be provided with an air break between the discharge from the equipment and an open tundish. The discharge from the tundish shall be trapped prior to entry into the drainage system.

4.19 GRADIENT OF PIPEWORK

All pipework shall be installed with continuous gradients to allow for drainage and/or release of air, according to the service concerned. Gradients shall be generally as follows for the various services.

Medium/low temperature hot water/chilled water/ condenser water	(Mains)	25 mm in 12 m
Medium/low temperature hot water/chilled water/ condenser water	(Branches)	25 mm in 6 m
Hot and cold domestic services		25 mm in 18 m
Gas, compressed air, steam and condensate		25 mm in 12 m

4.20 DIRT POCKETS

Dirt pockets shall be installed at the bottom of all pipework risers. They shall comprise a full bore length of piping not less than 300 mm long with a gate valve and drain cock to permit flushing. The dirt pocket shall be full pipe bore, however, the maximum size of gate valve shall be 50 mm.

4.21 PROTECTIVE PAINTING AND COVERINGS

All ferrous materials including pipework, fittings, sundry iron and steel brackets shall be primed before despatch to site.

The materials shall be first thoroughly cleaned from scale, rust, dirt and grease etc., and given one coat of heavy duty brushing quality zinc phosphate primer to an average dry coat thickness of 0.05 mm.

In the case of galvanised pipework and fittings an etch primer shall be applied prior to the zinc phosphate primer.

Immediately after erection all site welds and damaged areas shall be cleaned down to bare metal by wire brushing and painted with two coats of zinc phosphate primer. The whole steelwork installation shall then be painted with one further coat of zinc phosphate primer.

All paint shall be stored and applied strictly in accordance with the manufacturers instructions. All painting shall be carried out only on completely dry surfaces and the paintwork shall be left in sound condition.

4.22 GAS EQUIPMENT AND PIPEWORK

Gas pipework, equipment and systems shall comply fully with British Standard Code of Practice CP 331 Part 3, BS 6400, the British Gas Safety (Installation and Use) Regulations, the Gas Act 1972 and British Gas Publications and Specifications, in particular IM/16.

Where this Specification differs from the British Gas recommendations the higher standard shall be applied.

All necessary vent pipework to items of gas equipment (i.e. meters, gas boosters etc) to vent the gas to atmosphere at high level away from opening windows and escape routes etc., shall be provided in order to conform to the recommendations of British Gas.

The installation of any anti-flame device to the termination points on vents shall also be included in order to comply with the requirements of British Gas and the Area Gas Authority.

Any room containing gas equipment shall be ventilated in accordance with the requirements of British Gas and the relevant local Authorities.

Gas distribution pipework within the building shall be fire protected and the space around ventilated to atmosphere to the satisfaction of British Gas and the relevant local Authorities.

4.23 REFRIGERATION PIPEWORK INSTALLATION

Where required the complete system of refrigerant pipework shall be provided including installation, testing and commissioning of the pipework interconnecting water chillers with remote air cooled condensers including the necessary charge of refrigerant.

Pipework shall be located so that the access to system components is not hindered, and so that any components which could possibly require future maintenance are easily accessible.

Horizontal suction and discharge lines shall be pitched downward in the direction of flow to aid oil drainage with a downward pitch of at least 1 in 200.

Every vertical suction riser greater than 1 metre in height shall have a 'P' trap at the base to facilitate oil return up the riser. To avoid the accumulation of large quantities of oil, the trap shall be a minimum depth and the horizontal section shall be as short as possible.

The pipework shall be constructed from best refrigeration quality seamless drawn copper tubes to BS 2871 Part 2 Material C106 installed in accordance with BS 1306 and BS 4434, and internally degreased and cleaned.

The minimum acceptable pipe wall thickness shall be in accordance with the following table:-

Outside Diameter	Condition	Thickness ins
1/4" to 5/8"	Fully Annealed	0.036"
3/4" to 7/8"	Fully Annealed	0.040"
1 1/8" to 2 1/8"	Half Hard	0.048"
2 5/8"	Half Hard	0.064"
3 1/8" to 3 3/8"	Half Hard	0.080"
4 1/8"	Half Hard	0.104"

The pipework fittings shall be high quality brazing fittings. Dry nitrogen shall be passed through the internal side of the fitting whilst the brazing is carried out in order to prevent oxidation on the inside of the tube.

All possible care must be taken to ensure no foreign matter is deposited on the inside of the tube.

The refrigerant pipework installation shall be deemed to include the following, except where these items are supplied on the chillers, condensing units or other refrigeration equipment.

- Thermostatic expansion valves.
- Charging connections.
- Balance lines.
- Unions on flanges for plant and equipment removal.
- Dual port pressure relief devices.
- Sight Glasses.
- Liquid line filters/driers.
- Moisture indicating sight glasses
- Liquid line solenoid valves.
- Check valves.
- Flexible connections to chiller and condenser.

After completion the systems shall be commissioned and tested in accordance with Section 6 of this Specification.

4.24 VALVES, COCKS, STRAINERS AND VENTS

4.24.1 General

In addition to valves and cocks shown on the drawings, sufficient valves and strainers shall be provided, as detailed below, to ensure that the following facilities will be available.

Regulation of low temperature hot water and chilled water by means of isolating valves on the flow with commissioning sets (metering station and double regulating valve) on the return, having isolating valves and fine mesh strainers upstream of the commissioning set. Isolation of low temperature hot water and chilled water by gate valves.

Isolation and regulation of hot and cold water services by sluice valves on sizes 65 mm and above and by gate valves for sizes up to and including 50 mm for main service runs. Isolation and regulation of 'dead legs' or final connections to fittings on both hot and cold water services by stopcocks.

Isolation of gas services by gas cocks, ball valves and butterfly valves.

Isolation of compressed air service by wedge gate valves.

Isolation of oil service by gate valves.

Isolation of pressure or altitude gauges by gauge cocks.

Draining of system by plug cocks and hose unions.

Non-return valves shall be fitted where plant must operate on an automatic changeover basis or where flow reversal can occur.

Valves and stop cocks shall be installed using mating flanges or screwed fittings, as applicable, manufactured from compatible non-corrosive materials to ensure that no electrolytic action occurs.

Flanged valves shall have flanges and mating flanges manufactured in accordance with BS 4504.

The following is a general list of valves strainers and stopcocks. All valves, stopcocks and other fittings used on a particular service shall be suitable for the temperatures, working pressures and substance carried within that service.

Valves, strainers and stopcocks shall be as manufactured by the company stated under each section, or equal and approved.

All valves shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and to simplify maintenance.

4.24.2 LTHW Isolating Valves

Screwed gunmetal gate valves for sizes 15 mm to 50 mm and flanged cast iron gate valves for sizes 65 mm and above as follows:-

Maximum temperature 95°C

Maximum pressure (gauge) 6 bar

Size	Type	Class	Manufacture	Fig. No.
15-50	Wedge Gate	PN20	HNH Crane	33X D151
65-300	Wedge Gate	PN6	HNH Crane	M549 FM52

4.24.3 LTHW Regulation Valves

Regulation of LTHW circuits shall be by means of a commissioning set, on the return, comprising 5 times diameter of straight pipe, commissioning set (metering station and double regulating valve) followed where possible by 3 times diameter of straight pipe downstream.

A gate valve shall be installed on the flow at each commissioning set location for isolation purposes.

Regulating valves, orifice units and commissioning sets shall be fitted with Binder Twinlock test plugs.

Maximum temperature 95°C

Maximum pressure (gauge) 6 bar

Size	Type	Class	Manufacture	Fig. No.
15-50	Orifice Unit	PN20	HNH Crane	1000 D900
65-300	Orifice Unit	PN16	HNH Crane	M2000 DM900
15-50	D.R.V.	PN20	HNH Crane	1432DR D920
65-300	D.R.V.	PN16	HNH Crane	M733DR DM920
15-50	Commi-ssioning Set	PN20	HNH Crane	CV2432 D940
65-300	Commi-ssioning Set	PN16	HNH Crane	CVM2733 DM940

4.24.4 Chilled and Condenser Water Services

Specification as for LTHW as applicable for pressure condition.

4.24.5 Hot Water Service

Isolation on 'dead legs' or final connection to fittings by stopcocks. Isolation and regulation of main service runs and in plant rooms by gate valves. Regulation valves shall be lockshield pattern.

Size	Type	Class	Manufacture	Fig. No.
15-80	Wedge Gate	PN20	HNH Crane	33X D151
100-300	Wedge Gate	PN16	HNH Crane	M541 FM52
15-54	Stopcock with fixed jumper	BS1010	Y.I.M. Ltd.	501GM

4.24.6 Cold Water Service

Specification up to and including 54 mm as for Hot Water Service except that stopcocks on MCWS shall have loose jumper.

Size	Service	Class	Manufacture	Fig. No.
65-300	CWS (Sluice) BS 5163	PN16	HNH Crane	M599 FM121

4.24.7 Non Return Valves

Size	Service	Class	Manufacture	Fig. No.
15-50	HTHW	PN32	HNH Crane	48 D142
15-50	MTHW, and All others	PN25	HNH Crane	47 D138
65-300	HTHW	PN16	HNH Crane	736 FM492

65-300 MTHW, and All others	PN16	HNH Crane Crane Up To 65°C	651 FM492 FM469
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65-300. For temperature up to 65°C use rubber faced disc. For temperatures over 65°C use manufacturers special disc.

4.24.8 Gas Service

Gas cocks, ball or butterfly valves as follows:-

Size	Type	Class	Manufacture	Fig. No.
15-22	Cock		Y.I.M. Ltd.	206
25-50	Ball	PN16	Crane	D195
65-150	Butterfly	PN16	Crane	F610
200-300	Butterfly	PN16	Crane	F612
65-300	Butterfly	PN16	Audco	IBW

200-300 Butterfly valves shall be gear operated.

4.24.9 Compressed Air Service

Size	Type	Class	Manufacture	Fig. No.
15-50	Wedge Gate	PN32	HNH Crane	33 D159
65-300	Wedge Gate	PN16	HNH Crane	541 FM63

4.24.10 Oil Service

Size	Type	Class	Manufacture	Fig. No.
15-100	Gate	PN20	HNH Crane	33X D151

Valves used on oil services shall have special packings, lubricants and be air tested to twice working pressure.

4.24.11 Steam and Condensate Service

Parallel slide gate valves for steam isolation and condensate, and wedge gate valves for condensate isolation as follows:

Size	Type	Max. Pressure		Manufacture	Fig. No.
15-50	Parallel Slide	16b	sat	Spirax	RP31
65-300	Parallel Slide	16b	sat	Spirax	BSA2

Condensate

Size	Type	Class	Manufacture	Fig. No.
15-50	Parallel Slide	PN32	Spirax	RP31

Size	Type	Max	Pressure	Manufacture	Fig. No.
65-300	Parallel	16b	sat	Spirax	BSA2

4.24.12 Drain Cocks

Drain cocks on pipework and equipment shall be as follows (excluding HTHW):-

Maximum temperature 120°C Maximum pressure 10 bar (gauge)

Size	Location	Manufacturer	Reference
15-25	Pipework	HNH Crane	371 D340
15-50	Dirt Pockets (see 3.20)	HNH Crane	81 HU D344
15-50	Equipment	HNH Crane	81 HU D344

Gland cocks shall only be used on closed circuits, to the approval of the Local Water Authority.

4.24.13 Automatic Air Vents

Size	Service	Manufacturer	Fig No.
15 Screwed	LTHW up to 7 bar and 93°C	Charles Winn	C2
15 Flanged	MTHW up to 7 bar and 120°C	Charles Winn	MPHW
15 Flanged	MTHW up to 10.5 bar and 120°C	Charles Winn	HPHWF

4.24.14 Radiator Valves

Unless specified elsewhere each radiator shall be installed complete with a chromium plated wheel valve on the flow and a chromium plated lockshield valve on the return to BS 2767 as follows:-

Maximum temperature 120°C

Maximum pressure (gauge) 10 bar.

Size	Manufacture	Fig. No.
15-25 WV Straight	HNH Crane	2407CP D825
15-25 WV Angle	HNH Crane	2386CP D809
15-25 LS Straight	HNH Crane	2407CP LS D827
15-25 LS Angle	HNH Crane	2386CP LS D811

4.24.15 Ball Valves

All Sizes	Description	Manufacturer
15-50	Portsmouth type, BS1212 to suit mains pressure complete with copper ball	Charles Winn Ltd.
65-300	Equilibrium type	Guest & Chrimes 15 AI

4.25 VALVE LABELS

Labels shall be supplied, and securely attached to the valves, which shall identify the valves in accordance with the valve schedules of numbers and operation, in plant rooms, ceiling voids and ducts.

4.26 STEAM TRAPPING, DRAINAGE AND PRESSURE REDUCING OF STEAM MAINS

Refer to typical "Steam Trapping Arrangements" on the drawings.

4.27 SAFETY VALVES AND BOILER FITTINGS

Unless indicated elsewhere in equipment specification, all safety valves shall be as NABIC or equal and approved Figure No. 42, to the size and set to discharge at the pressures indicated on the drawing. The valves and boiler fittings shall be provided in accordance with BS 759, BS 779, BS 853, BS 855, BS 1123, BS 5500 and BS 6759.

Safety valves for boilers, heating calorifiers and all pressure vessels shall be provided irrespective of whether shown on the drawings or not.

Safety valves for steam, HTHW and MTHW shall be as indicated on the drawings and the Specification.

4.28 STRAINERS

These shall be of Spirax-Sarco Ltd., Crane or HNH manufacture, or equal and approved, to the sizes and types as detailed on the drawings, with a mesh of an approved size. Strainers shall be suitable for the working pressure of the system to which they are installed.

Strainers shall be flanged on sizes of 65 mm and over and shall be provided with drain facilities in the clean-out connection at the bottom of the body construction. Strainers shall be fitted with isolating valves upstream and downstream to facilitate maintenance.

4.29 TEST POINTS, GAUGES AND THERMOSTAT POCKETS

Unless otherwise indicated every heat generator or heat exchanger unit shall have no less than one temperature gauge and one pressure gauge for efficient control and running.

Each main branch circuit leaving a heat generator or heat exchanger plant room shall be fitted with a temperature gauge and pressure gauge on the flow and a Binder Twinlock test plug on the flow and return.

In order that the installations may be accurately balanced and set to work, test plug points for temperature and pressure tests shall be provided on flow and return connections to all items of equipment and around mixing valves.

Test plug points shall consist of connections made into the pipework and fitted with a Binder Twinlock test plug. The test plugs shall be extended to the surface of any insulation applied to the pipework.

Temperature test pockets shall be located and be of sufficient depth as to ensure a true reading of the fluid temperature. Where the pipework size is below 42 mm, the pipework accommodating the test pockets shall be increased locally to 50 mm so as not to affect the flow rate and response of the gauge/thermostat. Pockets shall be filled with mineral oil and the thermometers fixed so that the tails are truly subjected to the temperature of the fluid to be measured.

Boilers shall have a minimum of a flow temperature gauge, a return temperature gauge and a pressure gauge. Non-storage water/water heat exchangers shall have flow and return temperature gauges on both primary and secondary sides with one pressure gauge on the secondary shell side.

Circulating pumps shall have pressure gauges on both suction and delivery connections, and they shall be remote mounted. They shall be mounted on an adjacent wall in a position as shown on the drawing or to be agreed on site. Mounting boards shall be of 20 mm thick hardwood with bevelled edges and polished finish and of sufficient size to provide a neat workmanlike appearance. Identification labels for the relevant system and location shall be in traffolyte to an approved design.

Except where gauges form part of a 'packaged unit' they shall be no less than 100 mm diameter for mounting heights up to two metres from floor level and 150 mm diameter above two metres.

The gauges and ancillaries shall be manufactured by Brannan Thermometers Ltd., or equal and approved, to the following reference numbers:-

Thermometers	Vertical Pattern	Series 020 or 050
	Angle Pattern	Series 035 or 065
Pressure Gauges	Vertical Pattern	Fig. No. 37-62 or 37-92
Syphons	Vertical Ring	Fig. No. 39-015 or 39-017
	Angle 'U' Pattern	Fig. No. 39-011 or 39-013
Cocks	Female Ends	Fig. No. 39-001

All temperature gauges shall comply with BS 5235, dial type mercury in steel, and shall be installed with removable brass pockets filled with conductive gel.

All pressure gauges shall comply with BS 1780 Part 2, and shall be complete with syphons and gauge cocks and shall have 10 mm connections. Syphons shall be of the same material as the pipework.

The proposed calibration range for all gauges shall be submitted for approval prior to ordering of same.

All capillary tubes to remote gauges shall be supported upon their entire length, including the final connection to the equipment, on PVC coated tray.

SECTION 5

DUCTWORK SERVICES

5.1 GENERAL

The ductwork services installation shall be in accordance with the recommendations of the Heating and Ventilation Contractors' Association publication entitled:

DW/144

Specification for Sheet Metal Ductwork, Low, medium and High Pressure/Velocity, Air Systems including appendices and together with all current amendments and addenda.

One copy of the sheet metal ductwork specification DW/144 shall be kept on site and shall be freely open for reference purposes as and when any situation demands.

Ductwork shall also be prepared, delivered, stored and installed to HVCA Guide to Good Practice "Internal Cleanliness of Ventilation System" TR/19.

5.2 STANDARD AND QUALITY OF WORK

The manufacture of all ductwork shall be to a high standard of construction and quality. Any unsatisfactory or poor quality installation work shall not be accepted and shall be replaced at no extra cost to the Employer, and without delay to the contract programme.

5.3 INFORMATION TO BE PROVIDED BY ENGINEER

5.3.1 Pressure Classification

To be as Table 1 DW144. Refer also Particular Specification.

5.3.2 Leakage Classification

To be as Table 1 DW144. Refer also Particular Specification.

5.3.3 Positive and Negative Pressures

Refer Particular Specification

5.3.4 Materials

Unless otherwise advised in the Particular Specification all ductwork shall be fabricated from hot dip galvanised steel to BS EN 10142 : 1991 Grade DX51D+2.

5.3.5 Special System Requirements

Refer Particular Specification.

5.3.6 Inspection/Service Access Openings

Unless otherwise advised in the Particular Specification openings shall be provided for inspection and cleaning to HVCA document TR19.

5.3.7 Cleaning Access

Unless otherwise advised in the Particular Specification openings shall be provided to allow full cleaning as HVCA document TR19.

5.3.8 Regulating Dampers

Unless otherwise advised in the Particular Specification dampers shall be provided:

Balancing Dampers

At all system inlets and outlets, refer also to the Particular Specification for motorised dampers for out of use shut off.

Control Dampers

As indicated on drawings and at all major duct branches (major equals serving more than three outlets) and to all branches where the available pressure is higher than the system loss.

Unless otherwise specified control dampers shall be multi blade opposed with construction and installation to DW144.

5.3.9 Fire Dampers

Fire dampers are required in air distribution systems for fire containment, and they shall be provided where ducts penetrate walls or floor forming fire barriers, to meet the requirements of the Building Regulations applying at tender.

Fire dampers assemblies shall have a fire resistance equal to that of the fire barrier it penetrates and shall be fire tested to BS476 Part 20 and 22 all as DW144.

In all cases, damper blades when in the open position shall be completely clear of the air stream.

All fire dampers shall have installation frames to accommodate expansion.

Approval of the Fire Authority and Building Control Officer shall be obtained for all dampers with side over 1000 mm and for multi-damper assemblies.

All dampers shall close securely against the working dynamic pressure of the system, and shall be constructed to the standards of air tightness applying to the system in which they are installed.

Fire dampers shall be of the multi blade type of stainless steel construction, all as manufactured by Actionair Equipment Limited, South Street, Whitstable, Kent, CT5 3DU their Fireshield.

Where a fire damper has been requested to be activated by remote signal such as fire alarm then a combined smoke and fire damper shall be fitted.

Fire dampers should be located within the thickness of a fire barrier. Where this is not possible, the section of ductwork between the damper and fire barrier

shall have fire resistance equal to that of the damper itself, and be to the approval of the Fire Authority and Building Control Officer.

Each fire damper shall be held in the open position by a fusible link (set to release at a temperature of $72^{\circ}\text{C} \pm 4\text{C}$), and all blades must be tensioned to ensure immediate closure on release of the link.

5.3.10 Combination Smoke and Fire Dampers

Where smoke dampers are referred to in the Specification and/or drawings this shall mean combined. Smoke and Fire Dampers - These shall be tested and rated to BS476 Part 20 and 22. The closure of the fire damper under action of the thermal release element shall over all other subsequent signals.

Combination smoke and fire dampers shall have frames and installation as fire damper and shall be Smokeshield type by Actionair as above or as otherwise as other equal and agreed with the Engineer.

5.3.11 Flexible Ducts

Flexible ductwork may only be used to make final connections between distribution ductwork and terminal units and shall be kept as short and straight as possible and shall not be used to take up gross misalignment. Flexible duct shall be adequately supported to eliminate sagging and shall not exceed 1 m in length.

Where the flexible ductwork is to be insulated this shall be of the twin wall type factory applied, i.e. pre-insulated flexible ductwork, of an approved type and to the thermal conductivity equivalent to the adjacent thermal insulation.

All flexible materials and insulation shall not support combustion and shall be flame proof and vermin proof and be to the approval of the relevant local Authority.

5.3.12 Flexible Joint Connections

These shall be to DW144.

5.3.13 Air Leakage Testing

Refer to the Particular Specification for any requirements.

5.3.14 Protective Finishes

Refer to the Particular Specification for any requirements.

5.3.15 Fire Rated and Smoke Extract Ductwork

Refer to the Particular Specification for any requirements.

5.3.16 Internal Thermal/Acoustic Lining

Refer to the Particular Specification for any requirements.

5.3.17 External Thermal/Acoustic Insulation

Refer to the Particular Specification and the Standard Specification for insulation.

5.3.18 Air Leakage Testing

Refer to the Particular Specification for any requirements.

5.3.19 Attachment to Building Structure

Unless otherwise stated in the Particular Specification this shall be as DW144.

5.3.20 Air Terminal Units

Refer to the Particular Specification/Schedules/Drawings for terminal units.

All terminal units and plenums shall be supported from the structure not the ceiling grid.

5.3.21 Ductwork Layout Drawings

Ductwork drawings shall be produced using Autocad to a common scale (1:10; 1:20; 1:50; 1:100).

The Engineers design drawings will be made available in Autocad if produced that way.

Site dimensions shall be taken prior to the preparation of ductwork layout drawings. The ductwork manufacturer may develop his layout drawings to form manufacturing drawings as DW144.

5.4 HANGER AND SUPPORTS

All ductwork shall be adequately supported on hangers and/or brackets, and shall be positioned and spaced in relation to one another and to the building structure so as not to interfere with any other services and to allow for the required thickness of insulation.

Under no circumstances shall stranded wire hangers be employed.

Where ductwork is to be insulated hangers and supports shall allow insulation and vapour seal to be continuously.

Hangers and supports shall be to DW144.

All bolts, nuts, washers etc., shall be of a permanent nature with a non-corrosive finish such as cadmium plating, sheradising or galvanising as appropriate.

All un-insulated ductwork, metal flanges, brackets, drop rods and other components, whether galvanise or not, shall be primed after erection in accordance with Section 6.00 of the Specification.

5.5 VIBRATION ISOLATION AND NOISE INSULATION OF DUCTWORK INSTALLATION

All dynamic machinery shall be isolated from the building structure by vibration isolators which shall be purpose designed and selected to suit the machine. Vibration

isolators shall be as manufactured by Sound Attenuators Limited or equal and approved, and installed strictly in accordance with the manufacturers recommendations.

Purpose made attenuators and sound absorbent material shall be designed and installed to give the indicated acoustic performance to achieve the specified noise level in the spaces served, in any adjacent buildings and within plant rooms.

Attenuators shall be tested in accordance with BS 4718 and shall have acoustic infill material with a minimum rating of Class 1 for surface spread of flame as measured to BS 476, Part 7. The attenuator and infill material shall be suitable for the temperature, corrosive nature and moisture content of the air within the ductwork system and shall not degrade or erode within the maximum velocity range of the air movement through the attenuator.

Noise and vibration level information, based upon octave band analysis, shall be submitted for all items of plant and equipment.

Supports for ductwork shall include suitable isolators to limit transmission of vibration to the building structure.

5.6 MANOMETERS

All filters shall be provided with manometers to indicate the differential pressure across the filter. These shall be the inclined type with dual scale calibrated 0 to 500 Pa/50 to 1200 Pa. The gauge fluid shall be blended paraffin SG 0.785 at 18°C dyed bright red. The gauge shall have zero adjustment facility incorporated in the casing.

The manometers shall be positioned in approved locations.

5.7 DUCT THERMOMETERS AND CONTROL EQUIPMENT

Thermometers shall be 100 mm diameter dial type located in the ductwork as generally shown on the drawings but to a minimum to measure the following:-

Fresh Air Inlet Air Temperature.

Return Air Temperature to Air Handling Plant.

'On Coil' Air Temperatures.

'Off Coil' Air Temperatures.

Supply Air Temperatures (including individual zone temperatures where applicable).

The thermometers shall be type 026, with scale range - 20 to 45°C. The length of stem shall be to suit two thirds of the relevant duct width up to a maximum of 600 mm long.

The thermometers shall be as manufactured by Brannan Thermometers Limited, Cleator Moor, Cumbria, CA25 5QE, or equal and approved.

The thermometers and all control equipment mounted on ductwork, which is to be thermally insulated, shall be installed with a hardwood spacer block of the same thickness of the adjacent thermal insulation. The blocks shall be installed to allow the insulation finish to be "dressed" onto the block to allow the removal of the equipment without damage to the insulation or its integrity.

SECTION 6

THERMAL INSULATION

6.1 GENERAL

All thermal insulation work shall be carried out by an approved Specialist Thermal Insulation Contractor. Only skilled operatives shall be employed.

The Thermal Insulation Specialist shall be acquainted with all of the conditions of the works, including Specification, programming, hours of working etc., and he shall complete the work within such programme.

The thermal insulation work shall not be commenced, unless otherwise approved in writing, until the whole of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution section of the Specification.

The thermal insulation works shall be in accordance with the Building Regulations and all relevant Codes of Practices and British Standard Specification in particular BS 5970, BS 5422, BS EN 13166, BS 3958 and BS 5608.

All coverings shall conform to Class 'O' classification for surface spread of flame or comply with a non combustibility test as detailed in BS 476, Part 4.

The right is reserved not to accept any work of inferior quality or badly finished work. All joints, surface finishes, edges and overlaps shall not be allowed if they are of an irregular or dangerous nature.

6.2 THERMAL INSULATION OF PIPEWORK IN BOILERHOUSES, PLANT ROOMS AND TANK ROOMS

6.2.1 Heating, Condenser Water, HWS, Open Vent Pipework

Heating, HWS and open vent pipework installations shall be completely individually insulated with plain pre-formed mineral wool or phenolic foam sections, free from shot and coarse fibres, of 80/110 kg/m³ density.

The snap on sections shall be applied in 1000 mm lengths cut longitudinally and secured with 100 mm wide self adhesive Class 'O' tape at approximately 300 mm centres.

Water stops shall be installed at every 5 metres of insulation run. The water stops shall comprise a 13 mm space between sections filled with water proof mastic then taped with Class 'O' tape and identified "Water Stop Under".

The insulation shall be enclosed in pre-rolled stucco embossed aluminium cladding secured with closed head pop rivets on longitudinal and circumferential joints. All joints shall be overlapped by a minimum of 40 mm with purpose made clips, of an approved pattern for earth continuity bonding under the IEE Regulations 17th Edition. All longitudinal joints shall be hidden from view as far as possible.

The stucco embossed aluminium cladding shall be 0.6 mm thick up to 125 mm diameter pipework, 150 mm and above shall be 0.8 mm thick.

All bends, sets, tees and elbows are to be correctly mitred and segmented, with mineral wool to the necessary thickness to match the adjoining insulation and similarly enclosed in pre-rolled stucco embossed aluminium cladding but using specially segmented purpose made pieces, or mitred bends where applicable.

All insulation termination points shall be trimmed with polished aluminium coiled end capping pieces secured over the aluminium cover with closed head pop rivets.

Flange joints, unions, valves, strainers, etc., on all services shall have removable boxes manufactured from 0.8 mm stucco embossed aluminium, fully lined with mineral wool material secured to ensure the lining will not "bunch" or collapse when the box is removed and re-installed. Boxes shall have works folded edges where practicable, site cut edges shall have continuous grommet surrounds. Boxes shall be secured with quick release toggle fasteners to facilitate removal without disturbing the adjacent insulation, and particular notice of this requirement should be taken when setting out pipe routes.

Brackets and supports on pipework with a flow temperature of 95°C or above shall incorporate insulators of calcium silicate or other approved material suitable for the working temperature.

Each insulator shall be covered with a section of 0.8 mm thick stucco aluminium.

All thermal insulation work shall be carried out with no form of 'heat bridge' being present, which could affect the finish of the insulation. All insulation damaged or subject to failure due to 'heat bridge' shall be replaced at no cost to the Employer.

Under no circumstances shall pipes be married together within insulating material in any of the contract works.

All aluminium metal work shall be pre-formed, neatly and correctly installed, and manufactured to ensure a smooth, clean, uniform installation free from sharp and dangerous edges.

The thickness of the pre-formed mineral wool sections shall comply with the following table:-

Size of Pipe (mm)		Minimum thickness of Insulation (mm)				
Steel	Copper	LTHW up to 95°C & Condenser	MTHW & Condensate From 95°C	HTHW From 120°C to 10°C	Steam up to 350°C	HWS & Open Vents
15	15	30	40	50	50	30
20	22	40	40	60	60	40
25	28	40	40	60	60	40
32	35	40	50	65	65	40
40	42	40	50	65	65	40
50	54	40	50	65	65	40
60	67	40	50	75	75	40
80	76	50	60	75	75	50
100	108	50	60	75	75	50
125	133	50	60	75	100	50
150	159	65	65	75	100	65
200	-	65	65	100	125	-
250	-	65	75	100	125	-
300	-	65	75	100	125	-
Declared thermal Conductivity W/m°C		Up to 0.040	Up to 0.040	0.041 to 0.555	0.041 to 0.555	Up to 0.040

6.2.2 Chilled Water, MCWS, TCWS & All Cold Feed Pipework

Chilled water, MCWS and TCWS and all cold feed pipework shall be individually insulated with mineral wool or phenolic preformed sections, faced with factory applied Class 'O' covering.

The thickness of section shall be:

Chilled Water

15 mm to 25 mm : 25 mm thick

40 mm to 80 mm : 30 mm thick

100 mm to 200 mm : 40 mm thick

250 mm and above : 50 mm thick

MCWS, TCWS and Cold Feeds

All sizes 30 mm thick.

The sections shall be applied in 1000 mm lengths secured with an approved adhesive on longitudinal seams and fixed with 100 mm wide self-adhesive tape to match the Class 'O' covering on circumferential joints. The insulation shall be applied to form a continuous vapour seal and each pipe shall be insulated separately.

Water stops shall be installed at every 5 metres of insulation run.

All pipework supports shall incorporate rigid insulators of hardwood, or other material approved by the Architect.

The insulators shall be provided by the thermal insulation specialist for installation during pipework erection and shall be to suit the adjacent insulation thickness, 100 mm wide, bonded to aluminium foil tape to form an effective vapour seal. They shall be installed between the pipework and the supports with the vapour seal on the adjacent insulation being carried through the insulator support and not over the bracketing. A mastic vapour seal of Class 1 rating shall be applied between insulator supports and the adjoining insulation.

The insulation shall then be enclosed in pre-rolled stucco embossed aluminium sheeting as for heating pipework in Clause 6.2.

Flange joints, valve bodies etc., shall be insulated with 50 mm thick flexible mineral wool Class 'O' faced to ensure a symmetrical and neat appearance, secured with an approved adhesive and 100 mm wide Class 'O' tape to form a continuous vapour seal. The fittings shall then be encased in removable boxes, manufactured from 0.8 mm stucco embossed aluminium as for heating pipework in Clause 6.2, the boxes being installed without causing a break in the insulation vapour seal.

6.3 THERMAL INSULATION OF PIPEWORK TO ALL INTERNAL AREAS, SERVICE DUCTS AND VOIDS; EXCEPT BOILERHOUSE PLANT ROOMS AND TANK ROOMS

6.3.1 Heating, HWS, Condenser Water, Open Vent, Steam and Condensate Pipework

Heating, HWS, condenser water, steam and condensate pipework, and open vent pipework installations shall be completely individually insulated with pre-formed mineral wool or phenolic foam sections, free from shot and coarse fibre, of 80/110 kg/m³ density.

The snap on sections shall be applied in 1000 mm lengths cut longitudinally, with Class 'O' covering and secured with approved adhesive on longitudinal seams and fixed with 100 mm wide self-adhesive tape on circumferential joints to match the Class 'O' covering.

Water stops shall be installed at every 10 metres of insulation run.

Where bends and offsets occur the insulation shall be tailored to suit.

The thickness of the pre-formed mineral wool or phenolic foam sections shall comply with the table in Clause 6.2.

Where pipework media exceeds a temperature of 95°C and is situated within 2 metres of floor level 0.8 mm thick, stucco embossed aluminium cladding shall be employed. Brackets and supports on pipework with a flow temperature of 95°C and over shall incorporate insulators of calcium silicate or other approved material for the working temperature.

Under no circumstances shall pipes be married together with insulating material.

Flange joints, valve bodies, unions etc, shall be insulated with larger sections to form a neat and workmanlike appearance.

Valve bodies in restricted spaces, where approved, shall be insulated with 20 mm Armaflex insulation or equal and approved, formed to give a neat and workmanlike appearance with all joints sealed with an approved adhesive.

Taped joints will not be accepted.

6.3.2 Chilled Water, MCWS, TCWS and All Cold Feed Pipework

Chilled water, MCWS and TCWS and all cold feed pipework shall be individually insulated as for plant rooms, Clause 6.2, to form a continuous vapour seal but excluding the aluminium cladding, but then additionally secured with three 19 mm aluminium alloy securing bands.

Bracketing, flange joints, unions and valve bodies etc, shall be as Clause 6.2, but excluding the aluminium cladding.

6.4 THERMAL INSULATION OF EXTERNAL PIPEWORK, IN EXTERNAL DUCTS AND ALSO IN AREAS SUBJECT TO DAMP OR HUMID CONDITIONS

6.4.1 Heating, Condenser Water, HWS and Open Vent Pipework

Heating, condenser water, HWS and open vent pipework shall be individually insulated as Clause 6.3, all sections being taped on in lieu of aluminium bands and then covered with 0.6 mm thick stucco embossed aluminium sheeting 50 mm end and edge laps solvent welded, arranged to shed water.

6.4.2 Chilled Water, MCWS & TCWS and all Cold Feed Pipework

Chilled water, MCWS and TCWS and all cold feed pipework shall be individually insulated as Clause 6.3 with the addition of 0.6 mm thick stucco embossed aluminium sheeting 50 mm end and edge, sealed, and arranged to shed water.

The thickness of insulation and insulators on all sizes shall be 50 mm mineral wool rock preformed sections.

6.4.3 Steam and Condensate Pipework

Steam and condensate pipework shall be individually insulated as Clause 6.3 with the addition of 0.6 mm thick stucco embossed aluminium sheeting 50 mm end and edge laps solvent welded, arranged to shed water.

6.5 THERMAL INSULATION OF REFRIGERATION PIPEWORK

All refrigerant lines shall be insulated with closed cell type pipework insulation suitable for a temperature range -40°C to 105°C and shall have a mean thermal conductivity of 0.044 W/m°C at 20°C.

The insulation shall be Class 'O' Armaflex as manufactured by Armstrong World Industries Limited, Uxbridge, or equal and approved.

All joints etc., shall be bonded using Armstrong Armaflex adhesive to form a complete vapour seal along the length of the refrigerant lines.

After completion of the insulation all external insulation shall be painted with two coats of Armstrong Armafinish HN applied strictly in accordance with the manufacturers recommendations. Alternatively UV resistant Armaflex insulation can be used.

6.6 THERMAL INSULATION OF PLANT AND EQUIPMENT

6.6.1 Boilers

Boilers shall be supplied complete with an insulating jacket by the manufacturer.

6.6.2 Internal and External Water Storage Tanks

Internal and external water storage tanks shall be pre insulated to manufacturers recommendations and in compliance with BS 6700.

6.6.3 Refrigeration Water Chillers

Refrigeration water chillers shall be insulated on all surfaces below ambient temperature in accordance with the manufacturers recommendations.

6.7 THERMAL INSULATION OF DUCTWORK

6.7.1 Ductwork in Boiler House, Plant Rooms and Tank Rooms

All rectangular supply ductwork, including fresh air intakes, all ductwork fittings, attenuators, duct mounted heater batteries and cooler batteries, plenum boxes, dampers, fire dampers and extensions, flexible connections etc., shall be externally insulated with 50 mm mineral wool (rock) duct insulation or phenolic foam sections duct insulation, free from shot and coarse fibres, bonded with resin and faced one side with mineral wool or phenolic foam reinforced aluminium foil/kraft paper laminate. The material shall have a minimum density of 36 kg/m³. The insulation shall be secured by means of an approved adhesive and self-adhesive metal hanger on underside of ducts. All joints shall be sealed with 100 mm wide self-adhesive aluminium foil reinforced tape to form a continuous vapour seal, including ductwork and equipment flanges which shall be encased. For mineral wool the whole of the insulation shall be secured with galvanised lacing wire. Care shall be taken when applying the lacing wire so as not to perforate the insulation vapour seal. Any damaged insulation resulting from the application of the lacing wire shall be replaced free of charge. The insulation shall be 'dressed' around damper arms, test holes etc., in accordance with Clause 6.6.

All circular and flat oval supply ductwork and fittings shall be insulated as above, except with 50 mm mineral wool flexible duct insulation of a minimum density of 32 kg/m³.

The whole of the installation shall then be encased in 0.8 mm stucco embossed aluminium cladding with purpose made clips, of an approved pattern for earth continuity bonding to the IEE Regulations 17th Edition.

6.7.2 Ductwork in all Internal Areas, Ceiling Voids and Vertical Ducts, Except Boiler Houses, Plant Rooms and Tank Rooms

All rectangular supply ductwork, including fresh air intakes, all ductwork fittings, attenuators, duct mounted heater batteries and cooler batteries, plenum boxes, dampers, fire dampers and extensions, flexible connections where not pre-insulated etc., shall be externally insulated with 50 mm mineral wool rigid duct insulation or phenolic foam duct insulation, free from shot and coarse fibres, bonded with resin and faced one side with mineral wool or phenolic foam reinforced aluminium foil/kraft paper laminate. The material shall have a minimum density of 36 kg/m³. The insulation shall be secured by means of an approved adhesive and self-adhesive metal hanger on underside of ducts. All joints shall be sealed with 100 mm wide self-adhesive aluminium foil reinforced tape to form a continuous vapour seal, including ductwork and equipment flanges which shall be encased. For mineral wool the whole of the insulation shall be enclosed in 50 mm mesh galvanised wire netting with 150 mm overlaps at edges. Care shall be taken when applying the wire netting so as not to perforate the insulation vapour seal. Any damaged insulation resulting from the application of wire netting shall be replaced free of charge. The

insulation shall be 'dressed' around damper arms, test holes etc., in accordance with Clause 6.6.

All circular and flat oval ductwork and fittings shall be insulated as above, except with 50 mm mineral wool flexible duct insulation of a minimum density of 32 kg per cubic metre, which shall be laced prior to applying wire netting to prevent 'sagging'.

6.7.3 Ductwork in External Exposed Positions

All externally exposed supply and recirculation ductwork shall be insulated with 50 mm thick Phenolic slabs cut and shaped carefully and secured to the ductwork with an approved adhesive and self-adhesive metal pins and captive washers. On bends, branches and changes of direction the slabs shall be cut into strips, each strip mitred along its edge and assembled on to the outside contour of the fitting to ensure full coverage of the metal surface. Where flanges or stiffeners are encountered, these shall be covered with strips of insulation.

All externally exposed Supply, Extract and Fresh Air Intake ductwork shall be encased in 0.8 mm stucco embossed aluminium cladding with purpose made clips, of an approved pattern for earth continuity bonding to the IEE Regulations 17th Edition. All joints shall be sealed with an approved proprietary sealant.

6.7.4 Ductwork Supports for Insulated Ducts with a Vapour Barrier

Ductwork supports for insulated ducts with a vapour barrier shall be as detailed in DW/144, in part 6, incorporating a 50 mm rigid insulator between the vapour seal being continuous through the insulator support not over the bracketing.

6.7.5 Ductwork Access Openings in Insulated Ducts

Ductwork access openings in insulated ducts shall be installed as detailed in Section 5. with aluminium foil tape maintaining the vapour seal over the door flange when required.

6.7.6 Ductwork Specialised Fittings

Where test holes, damper arms, thermostats etc., are installed in the ductwork, the insulation shall be trimmed to give access and edges shall be vapour sealed and reinforced with aluminium angle for protection from mechanical damage.

6.7.7 Ductwork Flexible Connections and Flexible Ductwork

Ductwork flexible connections to air handling units, fans, fan coil units etc, and flexible ductwork, where continuation of vapour seal is required shall be insulated with mineral wool flexible duct insulation, free from shot and coarse fibres, bonded with resin and faced with reinforced aluminium foil/kraft paper laminate. The material shall have a minimum density of 11 kg per cubic metre and shall have a thickness of 25 mm in plant rooms and 50 mm in ceiling voids etc. The insulation joints shall be sealed with 100 mm wide self adhesive PCL foil tape to form a vapour seal.

6.8 THERMAL INSULATION PROTECTION

Any pipework or ductwork which is insulated, but which is likely to be accidentally damaged during maintenance, or in gaining access to any area or void, or at low level in plant rooms etc., shall be additionally protected with a non-corrosive casing of sufficient thickness, height and width to withstand the damage. Any damage within the contract period which may occur as a result of non-compliance with the requirement shall be made good at no cost to the Employer.

6.9 PAINTING OF EQUIPMENT, STEELWORK AND EXPOSED PIPEWORK AND EXPOSED DUCTWORK IN PLANT ROOMS, WALKWAYS, SERVICE DUCTS, TANK ROOMS AND BOILERHOUSES

All iron, steel and galvanised steel brackets, flanges, pipework, pipework fittings, ductwork etc, shall be painted with metal primer.

The material to be painted shall be thoroughly cleaned and painted with metal primer, all as specified in Clause 4.21 except that for galvanised materials a suitable etch primer shall be used in addition to the above.

6.10 THERMAL INSULATION AND CONTRACT IDENTIFICATION

All insulated and exposed pipework shall be identified by colour/safety indicated and basic colour identification bands to BS 1710.

The safety colour and code indication bands shall be 100 mm wide, between two basic colour identification bands each of a length of 150 mm. The identification shall be at centres of not more than 6 metres, and adjacent to all valves, items or plant, changes in direction and both sides where the pipework passes through walls, floors etc., and all service access points.

Pipe sizes, contents, flow and return (F and R) designation and direction of flow arrows in black, shall be applied on the basic colour identification band as detailed in Appendix 'E' of BS 1710.

Colours for colour code/safety indication and basic colour identification shall be as detailed in Tables 1, 2 and Appendix 'D' of BS 1710.

The safety colour, contents code and colour indication bands shall be applied by means of self-adhesive coloured or printed tape as supplied by J.C. Studios, Silk Screen Printers, Aireview Works, Aireview, Silsden, Telephone Steeton 52177, or equal and approved.

Flow and return (F and R) and direction of flow arrows shall be in Black with letters 25 mm high on 50 mm wide white self-adhesive tape applied in a continuous band around the pipe insulation.

Pipe contents (e.g. LPHW) shall be in Black lettering 25mm high on 50 mm wide clear self-adhesive tape with one set of identification letters per colour code.

Pipe sizes shall be metric in Black printed lettering 25 mm high on 50 mm wide clear self-adhesive labels.

All ductwork whether insulated or exposed shall be identified in accordance with DW/144, Appendix 'B' together with descriptive lettering approved by the Architect.

The materials employed shall be as for pipework identification (i.e. self-adhesive plastic).

6.11 CLEANING

Due allowance shall be made for the full and proper protection of all items of plant and equipment, electrical installation and building structure during the whole of the application of the insulation and painting works.

The necessary completion certificate will not be issued until the work has been properly carried out and the cleaning down on completion has been approved.

SECTION 7

COMMISSIONING AND TESTING

7.1 GENERAL

The Testing, Setting to Work, Regulation, Commissioning and Proving of all the installations shown on the drawings and as described in the Specification shall be completed in accordance with this Section.

The above procedures shall include the following:-

7.1.1 Testing

The physical testing and checking of the system to prove the integrity of the installation, including pressure and leakage testing, where appropriate.

7.1.2 Setting to Work

The process of setting the static systems into motion including cleaning and sterilisation, chemical treatment, and the process of starting and checking all plant and equipment.

7.1.3 Regulation

The process of adjusting the rates of flow in the distribution systems to achieve the values stipulated in the specifications and drawings. The process shall include measurement of all variables and conditions within the systems to demonstrate that the design parameters have been achieved.

7.1.4 Commissioning

The process of checking and adjusting all plant, equipment and installation components to ensure that the systems operate in accordance with specified conditions and manufacturer's requirements.

7.1.5 Proving

Further monitoring and testing of the complete installations to demonstrate that the systems operate and control within specified environmental parameters. Recording of space and plant conditions and provision of simulated loads will form a part of the proving process, where specified in the Supplementary Specification.

It is essential to ensure that the installations operate in conformity with the requirements called for in the design specification and drawings and no approval of site measurements will be given until such conformity is achieved. The installations will not be acceptable for handover until all commissioning and testing has been completed and approved.

The Architect shall be given the opportunity to witness all testing and commissioning and shall have access at all reasonable times to such parts of the Works, and of any Supplier's Works, as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance of plant.

Seven days written notice shall be given of the intention to carry out any test and all necessary adjustments shall have been carried out prior to commencing such test. In the event of the works being incomplete and causing a postponement of the notified test date, or of the installation failing to pass the test or commissioning, the right is reserved to deduct from the Contract Price all reasonable expenses incurred by the Employer's representative in attending repetitions of the test.

Allowance shall be made for testing and commissioning the installation in sections in order to conform with the programme, including sectional testing of systems which are to be concealed or insulated prior to the main test being carried out.

All labour, supervision, materials, power, fuel, stores, apparatus and properly calibrated and certified instruments for carrying out testing and commissioning in accordance with the Specification shall be included.

Allowance shall be made for attendance by the Employer's Insurance Company Inspector to witness all testing of pressure vessels and accessories in accordance with the Factories Act.

Throughout the testing the safety of all personnel and equipment in the test area shall be maintained.

7.2 CODES OF PRACTICE

Testing and Commissioning of the installations shall be carried out in accordance with the relevant British Standards and Codes of Practice, the BSRIA Application Guides and the CIBSE commissioning codes:-

- A** Air Distribution
- B** Boiler Plant
- C** Automatic Control
- R** Refrigeration
- W** Water Distribution.

The CIBSE codes are obtainable from The Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London, SW12 9BS.

A full set of the relevant guides and codes shall be kept permanently on site and the commissioning engineers shall be fully conversant with methods outlined therein.

7.3 INSTRUMENTS USED IN TESTING

The instruments used during the commissioning and testing shall have been re-calibrated by the Manufacturer prior to carrying out any measurements on site and shall be of the types detailed in the relevant BSRIA Application Guides.

Manufacturer's instructions relating to test instruments shall be strictly adhered to.

Written documentation shall be submitted, from the instrument manufacturer's, confirming the accuracy of the instrument and its serial number in order to

demonstrate that the instruments being used are bonafide and capable of registering to the degree of accuracy acceptable.

Manufacturers of plant who put forward their own test figures for inclusion shall also state, in writing, the type of instruments used to obtain the figures quoted.

7.4 SPECIALIST COMMISSIONING ENGINEERS

Specialist commissioning engineers shall be employed to carry out the site regulation, setting to work, commissioning and proving.

The engineers shall be fully trained in the use of test instruments and methods of testing and commissioning and the right is reserved to require the removal from site of any engineer who is deemed to be unsuitable for the required task.

The commissioning of all items of plant and equipment and their associated control and electrical systems shall be carried out by the Manufacturer's authorised engineers.

7.5 EQUIPMENT AND COMMISSIONING CERTIFICATES, SCHEDULES AND DRAWINGS

The design data for items of plant and equipment is generally as summarised on the design drawings and in the Specification.

Equipment and commissioning schedules shall be completed and submitted during commissioning, indicating the design conditions, site test readings and observations.

Schematic drawings of all systems shall be provided by the Contractor detailing the design data and locations of all measurements and tests. These drawings, in conjunction with the schedules, shall provide a complete record of design and test data for all sections of the various systems.

Upon completion of final balancing and commissioning of the systems, the test results shall be submitted in duplicate to the Architect for comment.

The approved Equipment and Commissioning Schedules shall then be incorporated into the Operating and Maintenance Instructions.

Two copies of "as made" drawings of all tanks, receivers, calorifiers, pressure vessels and boilers producing water or steam above 100°C, shall be submitted to the Employer's Insurance Company, prior to manufacture.

Two copies of all test certificates shall be provided, in addition to which copies shall be incorporated into the Operating and Maintenance Instructions.

7.6 PRE-COMMISSIONING FLUSHING, CLEANING, CHEMICAL TREATMENT AND DISINFECTION

The Contractor shall employ a reputable specialist to carry out the flushing, chemical cleaning and treatment of all systems. This specialist shall be responsible for water analysis including the mains supply and for the design, supply, installation and operation of the flushing, cleaning and chemical treatment processes.

The flushing and chemical cleaning of LPHW and chilled water systems shall be carried out in accordance with BSRIA Application Guide 8/91. All treatment shall comply fully with Statutory Authorities Health and Safety Regulations.

All manufacturers and suppliers of equipment incorporated into the wet systems shall be notified of the proposed cleaning and chemical treatment processes and their approval obtained. Manufacturers or Suppliers recommendations in relation to cleaning or chemical treatment shall be adhered to.

Prior to carrying out chemical cleaning and/or treatment processes, the following actions shall be taken.

- All foreign matter shall be removed.
- Certified pressure tests shall have been carried out.
- All water used for pressure testing shall be inhibited. Remaining sections shall be left full after pressure testing.
- Where there is a risk of freezing inhibited mono-ethylene glycol shall be used.
- Circulation shall be demonstrated on all parts of the system. All valves other than those used to isolate sections shall be left fully open. Balancing and certification of water systems shall be carried out after the flushing cleaning and passivation operations.
- Ensure that no damage shall occur to any item of plant or equipment as a result of the cleaning and chemical processes.
- Chemicals used shall be compatible with system materials.
- Temporary bypasses shall be provided as necessary.
- Dirt pockets shall be installed at low points to facilitate solids removal.
- Check all drainage, to be used when discharging water or effluent from the systems has been tested and approved and that the drainage system is fully operational.
- Dead legs more than 3 pipe diameters in length shall be looped to allow effective cleaning.
- Strainer baskets and filter media incorporated within systems shall be removed and where necessary stool pieces installed.
- Temporary strainers and filters shall be installed as required for removal of solids during cleaning and chemical treatment processes.
- Suitable supply and drainage points shall be provided with 50mm minimum connections, properly sited and installed either valved or plugged.
- All automatic/manual air vents shall be fully commissioned.
- All COSHH regulations shall be complied with during the chemical cleaning and treatment of the system.

- Where required by the Local Water Authority, effluent tanks shall be provided for the storage of all waste products of cleaning and chemical treatment processes.
- After obtaining Local Water Authority approval, the waste produces shall be neutralised and discharged to drain or disposed of by removal to an authorised registered site.

After completion of the chemical cleaning the right is reserved to instruct the removal of up to ten sections of the pipework installations and to have them inspected and examined.

If the test and inspection should prove that the cleaning is to the required standard, the Employer will pay the costs incurred in removing, testing and replacing the sections of the installation. If, however, the test and inspection show that the cleaning is below standard and incomplete, no costs or fees incurred by the tests shall be borne by the Employer.

If any result suggests that cleaning the whole installation or system is incomplete, the pre-commissioning cleaning shall be continued until the witnessing is to the satisfaction of the Architect. The right is reserved to deduct from the Contract Price all reasonable expenses incurred by the Architect in attending the repetition of the witnessing.

Immediately upon completion and approval of the pre-commissioning cleaning, the water treatment of all systems shall be carried out as described elsewhere in the Specification.

An approved water treatment specialist shall be employed to carry out the flushing, disinfection and chlorination of all new domestic hot and cold water installations, and existing installations where alterations have been made, including incoming and rising mains, tanks and tank cold water down services.

It shall be presumed that contamination has occurred on all new pipework installed, all sizes. As such all new services shall be disinfected as the Standard Sections, British Standard BS 8558, and British Standard PD 855468:2015 ; Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages. The Contractor shall note the existing pipework also serves other areas and shall take all precautions to ensure disinfecting agents etc. do not migrate to other areas.

A method statement will be required to be submitted by the Contractor for comment two weeks prior to the intended disinfection.

A further set of tests shall be carried out during the Defects Liability Period to ensure any "hide out" of bacteria due to latent contamination is not present.

If the tests prove the presence of bacteria, the re-chlorination of any or all systems shall be undertaken at no extra cost.

All disinfection, chlorination and pre-commissioning cleaning shall be carried out in accordance with the requirements of the Local Authority.

Domestic water services shall be tested, set to work and commissioned as the Standard Sections and as the relevant other sections on completion of the works.

After flushing, samples for the following bacteriological analysis shall be taken and analysed:

- Total viable counts (TVC) measured at 22°C;
- TVC measured at 37 °C;
- Coliform bacteria;
- *Pseudomonas aeruginosa*;
- *Legionella* (species); and
- Disinfection residuals (taken concurrently with the microbiological samples).

If the tests reveal the presence of any bacteria then the Contractor shall disinfect the system again at no extra cost to the client and repeat until the test certificates read satisfactory results. The Contractor is invited to test the site prior to commencement of the works at no cost to the client. No extras after commencement of this Contract will be considered on the basis that there may have been an issue present on site previously unknown.

The supervising microbiologist shall determine the number and method of collection of samples.

The Contractor shall also allow for daily periodic flushing (for 5 minutes every 24 hours) of all domestic water systems between testing and handover.

New pipework is also to be hydraulically tested and new outlets to be temperature tested as laid out in other sections.

The Contractor shall make allowances for ensuring that testing and commissioning of the domestic water installations is within the Contract programme.

7.7 PIPEWORK TESTING, COMMISSIONING AND REGULATION

All water systems shall be tested, commissioned and regulated to ensure that they operate with the correct performance, temperatures, pressure and flow rates in accordance with the Specification and drawings.

The whole of the pipework installations shall be hydraulically tested to twice the working pressure of the system or 4 bar, whichever is the greater. This pressure shall be maintained for a period of two hours in each case, and allowance shall be made for attendance upon the Architect during the progress of such tests. Arrangements shall be made for the Water Authority to witness these tests, should they require to do so. Any equipment fitted which is not suitable for the test pressure shall be adequately protected or isolated from the system during the test.

Regulation shall be carried out in accordance with the relevant BSRIA Application Guides and CIBSE Commissioning Codes.

Refrigeration, compressed air and gas installations shall be pressure tested as described elsewhere in this Section.

7.8 DUCTWORK TESTING, COMMISSIONING AND REGULATION

All air systems shall be tested, commissioned and regulated to ensure that they operate with the correct performance, temperature, pressure and flow rate in accordance with the Specification and drawings.

The ductwork pressure classifications shall be as detailed in the Supplementary Specification relating to this Project.

All air handling equipment and air system plant components shall be measured and tested for pressure differential and flow rate to ensure that the installation and manufactured components comply with published and specified data.

The measurement of velocity within a ductwork installation, to determine volume flow shall, unless stated otherwise, be carried out in accordance with BS 1042.

Regulation shall be carried out in accordance with the relevant BSRIA Application Guides and CIBSE Commissioning Codes.

7.9 DUCTWORK AIR LEAKAGE TESTING

Air leakage tests shall be carried out in accordance with DW/143 and DW/144. The maximum leakage rates shall be as Table 17 of DW/143.

"High Pressure" classified systems shall be tested.

"Low" and "Medium" classified systems shall be tested where required in the Supplementary Specification.

The ductwork pressure classifications shall be as detailed in the Supplementary Specification relating to this Project.

The results of the leakage tests shall be submitted in the manner indicated on the Specimen Test Sheet in DW/144. The measurement on site of duct lengths, cross-sectional area, and surface area of the ducts under test shall be carried out and recorded at the time of the test.

All supply and extract and recirculation air ductwork on VAV and Induction unit systems shall, unless stated otherwise, be tested generally in accordance with DW/143 and DW/144 high pressure air leakage tests.

7.10 REFRIGERATION INSTALLATION

Refrigeration installations shall be tested and commissioned strictly in accordance with the parameters and procedures set out in the CIBSE Commissioning Code and BS 4434 Part 1.

The maximum working pressure, as defined in BS 4434, shall be obtained from the relevant refrigeration equipment manufacturer/supplier. The values of normal operating pressures, pressure limiting devices, relief devices, and test pressures shall be as defined in BS 4434.

7.11 GAS INSTALLATION

Gas installations shall be tested and commissioned in accordance with British Gas recommendations, BSCP 331, BS 6400, and British Gas Publications IM/2, IM/5 and IM/16.

The pressure test shall be carried out at twice the maximum working pressure or 5 kN/m², whichever is the greater.

7.12 COMPRESSED AIR

The whole of the compressed air installation shall be tested to 1.1 times the maximum working pressure of the system using Nitrogen or other inert gas. The test pressure shall be maintained for a period of one hour to establish that the pressure can be maintained and to allow for leakage checks to be carried out. The value of the maximum working pressure shall be equal to the set value of the relief devices.

The testing with inert gas could, in the event of failure, give rise to serious risk to personnel, and precautions should be taken to prevent completely the danger to people and property.

All personnel not engaged in the testing operations are to be evacuated from the area and a preliminary check is to be carried out with a pressure of not more than 1.5 Bar. The pressure shall be increased gradually in steps, providing time for conditions to stabilise and to check for leaks.

7.13 UNDERGROUND MAINS : PIGGING

Underground mains shall be "pigged out" by the introduction into the mains, prior to filling and testing, of a 300 mm polyurethane "pig".

The pig shall be inserted into the open ended main and shall initially be approximately one and a half times the internal diameter of the main before being compressed manually into the main.

A compressor shall be connected to the main behind the pig to force it down the main until it is expelled from the opposite open end completely removing any foreign matter.

The compressor shall be capable of developing a pressure of 10.5 Bar with an air quantity 0.22 cubic metres/second.

Branch mains shall be pigged prior to main runs and the smaller pigs and foreign bodies deposited in the main runs shall be removed when the latter are pigged.

Any open end mains or branch mains connected to the main or branch mains being pigged shall be blanked off.

Sufficient notice of all "pigging out" shall be given to allow the Architect to be in attendance should he so wish.

7.14 AUTOMATIC CONTROL SYSTEMS

Current wiring diagrams for all electrical equipment associated with the plants being commissioned, including motor control circuit details and inter-lock arrangements, shall be obtained from the relevant manufacturers prior to commissioning on site.

All commissioning and testing shall be included as called for in Section 8.00 of this Specification.

SECTION 8

AUTOMATIC CONTROLS

8.1 GENERAL

All work necessary to complete the installation and demonstrate the safe operation of the automatic control systems, to meet and prove the design criteria, all as described in this Specification and the Supplementary Specification and drawings shall be included.

The controls manufacturer shall be responsible for the interpretation of the design intent, set out in the Specification and Drawings, into the design of the control systems to provide a complete operational installation.

All parts of control systems and items of equipment shall be compatible within any system, between systems and with controlled equipment.

Siting of items of control equipment shall always be such that access for adjustment and maintenance purposes is not impeded. However, where items of control equipment are mounted in accessible positions within occupied areas, the control items shall be provided with means to discourage unauthorised interference.

Where items of equipment are mounted in areas where accidental damage is likely from physical movement and/or environment, dust or vapour, the items shall be protected from such hazards.

Control systems shall be arranged such that, in the event of electrical or pneumatic power failure or other abnormal operating condition, inherent fail-safe features prevent potentially hazardous conditions arising. Equipment shall be fail-safe for protection from frost, excessive temperature or pressure build up.

8.2 DRAWINGS AND INFORMATION

Drawings detailing all electrical loadings of plant and equipment associated with the works and manufacturer's drawings of all electric, electronic and/or pneumatic work associated with the Contract shall be prepared and submitted.

The drawings shall be in the form of single line schematic diagrams and comprehensive wiring diagrams, clearly showing the location and functions of each component with the manufacturer's figure number or other identifying symbol, and noted to show the components specified. Manufacturers typical wiring diagrams are not acceptable.

Any items of wiring which are to be provided by others shall be designated clearly on the drawings. Any such indication will not be accepted as justification of incorrect interpretation of the Specification.

The voltage, starting current, running current and duty in kW shall be clearly marked against each motor and all associated components shall be suitable for all conditions resulting from this data.

The voltage, current and normal status of all electrical components shall be clearly marked, together with particular requirements for size and type of wiring and number of cores.

All control panel terminations shall be identified separately by numbers, and all fuses and contactors shall be clearly marked with the required ratings and settings.

The drawings shall be integrated, so that they form complete details for the installations, and the pneumatic and wiring details show all information for each group of components so that they function as intended. Manufacturer's standard wiring diagrams or 'typical' wiring diagrams of individual components will not be accepted.

Four copies of the electrical wiring and pneumatic diagrams complete with electrical and control equipment details and four copies of the control panel fascia layout drawings shall be submitted for approval.

Drawings submitted for comment will be checked to ensure that they do not contradict the Design Intent and comment will be so limited. An allowance of 10 working days from receipt should be made for each such appraisal.

Twelve copies of the finalised drawings and details shall be provided for distribution through the Contract.

All electrical work will, unless otherwise indicated, be carried out by others.

8.3 CONTROL PANELS

All grouped controls shall be enclosed in purpose-made panels. The approximate location of the panels shall be as indicated, but final positioning shall be agreed on site.

The control panels shall be delivered, off loaded, positioned and secured.

Control panels shall be manufactured from cold rolled sheet steel of minimum thickness 3 mm, double folded and seam welded to form a rigid construction with no sharp edges or corners and shall be completely corrosion protected by phosphate treatment with semi-gloss acrylic stove enamelling to an approved BS 4800 colour, electrostatically applied. Wall mounting brackets and screws, rails, mounting plates and gland plates shall also be suitably corrosion protected and painted.

Panels shall be totally enclosed, internally wired with no live terminals or components exposed. Earth continuity shall be provided to the panel doors, instrument panels and gland plates.

The design of the control panel shall be such as to enable all normal maintenance to be carried out from the front of the panel through hinged doors.

Doors on wall mounted control panels shall be semi-recessed with 180° opening, concealed type lift off hinges, compression locks and 2 No. metal removable handles.

Floor mounted panels shall be either of the cubicle type or cupboard type.

Each cupboard type floor mounting panel shall have single doors for widths up to 840 mm and double doors for widths over 840 mm all with top hinged instrument panel section having opening stays. The doors shall be secured with lockable lever handles having three point closure and 2 No. spare keys. The instrument panel section shall be secured by compression locks and 2 No. all metal removable handles.

Floor mounted panels shall be provided with plinths, lifting eyes and bottom plates.

The pneumatic sections of control panels and all adjustable control equipment shall be compartmented to allow access without the necessity to isolate the door interlocked main isolators.

All doors and openings shall close on to neoprene or rubber gasket seals.

The layout of equipment within control panels shall be designed so as to provide sufficient space for maintenance and for the termination of the relevant tubing and cable sizes. Double banked terminal blocks shall not be permitted. All work shall be closely co-ordinated with that of the Electrical Installation in every respect, and adequate cable entries shall be provided in approved locations prior to manufacture. In addition, details shall be obtained of the incoming and outgoing cables and due allowance made both in the size of the panel for cable bending radii and for spreading, and in the size of terminations for the cable core dimensions. Cable and tubing entries shall be complete with blank stove enamelled gland plates.

The internal equipment mounting plate shall be finished in white and all equipment shall be secured to purpose made rails or mounting plates secured by shake-proof screws and washers or other vibration resistant fastenings.

Control equipment within the panel shall be identified with traffolyte type labels.

Internal wiring shall be fully identified at each end of each cable by numbered ferrules with power wiring and control wiring segregated and enclosed in separate PVC slotted ducting with removable covers. Wiring to equipment mounted on doors shall be enclosed in spiral wound plastic sheathing or secured with plastic harness straps.

Wiring which crosses door hinges and/or is subject to possible movement, shall be PVC insulated flexible stranded cable. All cables shall be sized to meet particular current requirements and shall be protected by suitable rated protective devices. All conductors serving three phase equipment shall be labelled in accordance with BS7671 (latest edition) of the IEE wiring regulations. All conductors shall be manufactured from electrically pure copper.

Each panel shall be complete with door interlocked mains isolator which shall also isolate all incoming control cables etc, that are fed from a different source of supply. The isolator shall be suitably labelled ON/OFF and be complete with a warning label indicating the presence of '415 volts 3 phase' or the relevant voltage to be employed.

All indicator lamps shall be of the transformer type and colour coded generally to BS 4099 Part 1 with schedules submitted for approval.

All switches shall be of the rotary type suitable for the required individual operation.

All miniature circuit breakers shall be in accordance with BS7671 the IEE Regulations for Electrical Installations: Latest Edition. Control panels shall be delivered to site without fuses, which are not to be re-installed until the whole of the wiring installation has been approved by the Control Systems Manufacturer. Six spare fuses shall be provided of each type installed, in a purpose made box within each panel, after completion of commissioning.

All equipment employed in the construction of the control system shall conform to the relevant British Standard and IEE Regulations current at the time of manufacture.

The pneumatic sections of the panels shall be complete with all necessary electro-pneumatic and reverse acting relays, receiver controllers, pressure reducing valve sets and all associated equipment to provide a complete and working installation. The tubing and fittings on the pneumatic copper materials shall be correctly bracketed and earthed, and installed in a neat and workmanlike manner.

The control apparatus on the panel fascia shall include 'Panel Live' and 'Control Circuit Failed' lamps with associated fused protection and shall be mounted and identified on white traffolyte labels in one complete section. The traffolyte shall be secured by round headed chromed screws and shall be engraved in black lettering in general, but red lettering for fire equipment or cautionary information, where approved.

All indicator lamps, rotary switches, push buttons, instruments and controls mounted on the panel shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and to simplify maintenance.

Externally visible equipment shall be flush mounted with minimum projection and shall be fixed securely to the front panel or other members.

All panels shall to be encased in 50 mm thick fire retardant rigid foam slabs and polythene enveloped, then clad in timber framework of sufficient strength to prevent damage in transit, during site positioning and during the course of the contract works. The protection shall not be removed until approval has been received in writing.

A functional test simulating operation of the complete panel shall be performed at the manufacturer's works prior to delivery to site. Notification shall be provided of when the works inspection and test is to be carried out. Panels shall not be encased in protection and despatched until fully approved in writing.

Unless denoted otherwise in the Specification, the starting of motors shall generally be Variable Speed Driven (see section 8.4).

8.4 VARIABLE SPEED CONTROL

8.4.1. General

All motors covering pumps, HVAC systems, fume cupboards and other specialist systems shall be provided with a Variable Speed Drive (VSD) to aid carbon reduction targets.

The Contractor shall ensure following technical details are adhered to by the Manufacturer when acquiring these drives:

1. The manufacturer shall be able to provide a simple spreadsheet for the range of drives offered to enable payback, energy usage and carbon emissions to be calculated for the range of drives offered.
2. Details of true power factor at 50% and 100% load together with total harmonic distortion level shall be provided with the quotation.

3. With the quotation technical details, installation and maintenance requirements are to be provided in the form of brochures and manuals for the drive range offered.
4. The VSD shall be a manufactures standard item, free from any known obsolescence and with a minimum spares supported life of 10 years from installation.
5. All VSD's shall be available from a single range to minimise maintenance and spares requirements.
6. A five year like for like replacement warranty is sought on the VSD. The manufacturer is to advise if this is acceptable and detail any associated caveats to this warranty.
7. The following shall be included as standard on the range of VSD offered:
 - i. Class 2 EMC filters
 - ii. Harmonic current standard requirement to BS EN 61000-3-12. Measures used to minimise harmonic current as part of the VSD unit shall be stated. Actual total harmonic distortion level to be advised as part of manufacturers technical details.
 - iii. The drives shall be able to maintain full motor output between -10⁰ and + 50⁰C on continuous operation.
 - iv. Efficiency shall be 95% or better, details to be provided with quotation.
 - v. Inbuilt timers, real-time clock and calendar to provide accurate time and date stamps for monitoring and event scheduling.
 - vi. Protection functions shall include as a minimum: overvoltage, undervoltage, earth leakage, motor short circuit, overcurrent, phase loss, overload and underload supervision and stall protection.
 - vii. Modbus communication output and Trend system compatibility.
 - viii. Pre-programmed and selectable standard HVAC applications with start up assistance to ensure ease of commissioning and maintenance.
 - ix. Option of either miniature circuit breaker or fuses as protective devices to assist in discrimination issues.
 - x. On board local means of lockable isolation.
 - xi. Maintenance alerts via Trend together with interactive diagnostic assistance.
 - xii. Fault logger detailing time and date. Manufacturer to detail other fault finding capabilities available.
 - xiii. Flux optimisation to reduce energy and lower noise levels.
 - xiv. Flexible mounting arrangements – wall, floor and flange as standard.
 - xv. Details of routine maintenance requirements. These shall be provided as part of the quotation.

8.4.2. BMS Interface

The BMS interface is to display the following for all variable speed controlled motors:

- Speed control output
- Stop and start

- Speed monitor
- Fault
- Spare interface

8.5 REMOTE MOUNTED CONTROL EQUIPMENT

All remote mounted sensing elements and control equipment necessary for the correct functioning of the installation shall be provided. All pneumatic equipment and electrical equipment attached to pipework, ductwork and plant shall be fixed in the final positions. Electrical equipment, not being wired under the Contract which is to be mounted internally or externally on the building fabric, shall be handed over for fixing and wiring by others.

Control equipment sensing liquid temperature in pipework shall be:-

- Provided with means for withdrawal for calibration, servicing etc, without the need for draining the system.
- Positioned so that the active part of the element is wholly within the liquid.
- Positioned so that the element is not less than 12 pipe diameters downstream from a point of mixing.

Control equipment sensing temperature of air in a duct shall be positioned so that:-

- The element is not subject to radiation.
- Account is taken of temperature stratification in the positioning of sensors for frost, high or low temperature and averaging.
- If of the capillary averaging type, it is installed on a suitable framework and is suitably arranged for servicing.
- The element is constructed of suitable material for the conditions appertaining.

8.6 PNEUMATIC INSTALLATIONS

Where pneumatic controls are provided, the system shall include not less than two oil-free air compressor receiver units, each entirely separate with no common controls and each sized to provide the full air quantity and quality at maximum demand.

The capacity of each compressor unit shall be such that each shall run for not more than twenty minutes in any one hour. The controls of the compressors shall be arranged so as to maintain the required pressure automatically with standby compressors being started automatically on drop in set pressure.

Each compressor receiver unit shall be complete with intake and discharge filters, air drier, isolating valves, pressure reducing and relief valves, pressure gauges and receiver automatic water separator with drain to nearest gulley. Safety valves and fittings shall be manufactured and tested in accordance with BS 1123.

Pneumatic control systems shall be complete with all the necessary pipework and accessories to form a complete installation.

8.7 SUPERVISION, TESTING, SETTING TO WORK, COMMISSIONING, CALIBRATION AND PROVING

The controls supplier shall accept total responsibility and include for the services described below.

The services shall include all necessary visits to site by the control Supplier to carry out the following:-

1. To identify and locate the control equipment and advise on the correct method of installation.
2. To discuss with and advise all parties on the correct method of wiring and connecting the equipment.
3. To check that the equipment has been correctly installed.
4. To check that the electrical wiring has been correctly installed and connected, including electrical continuity test by the control manufacturer upon completion of the wiring installation.
5. Pre-commission control equipment at testing and balancing stage of each plant.
6. To commission the installation and to issue, in triplicate, a certificate of commissioning, which must be complete with all control equipment settings. The certificate shall not be issued nor the system accepted until the system has been demonstrated in full operation to indicate the various control actions and the satisfaction of the design conditions to the acceptance of the Architect.
7. Continuously monitor the system and building conditions for a period of two weeks to ensure stabilisation of the building and control systems. This monitoring shall not commence until item 6 above has been accepted. The Contractor shall include for the provision of all temporary monitoring equipment to allow this exercise to be carried out.
8. Instruct the Clients staff in the running and maintenance of the automatic controls installation in accordance with Section 3 and Section 7.
9. A further visit and report shall be made immediately prior to the termination of the defects liability period to ensure the complete and accurate operation of the equipment.

Attention is drawn to Section 7 of the Specification, which is to be read in conjunction with this Section.

SECTION 9

AIR CONDITIONING REFRIGERATION SERVICES

9.1 GENERAL

The design and installation shall comply with BS 4434 : 1995 regarding refrigerant gas discharge into offices.

Systems are to utilise refrigerants with minimum ozone depletion potential.

The indoor evaporator units/heat pumps, condenser units and integral control equipment shall be supplied and delivered to site in fully protective packaging by an approved supplier/distributor.

The complete refrigeration installation shall be supplied, installed, tested and commissioned in accordance with the requirements as detailed within the manufacturers standard technical specification and the general refrigeration specifications as detailed hereafter.

The fixing of all fan coil and condenser units, installation of all refrigerant pipework and full commissioning shall be performed by a manufacturer approved installer.

Witnessing of the commissioning of the entire refrigeration installation and final inspection shall be carried out by both the specialist refrigerant systems installer and the distributor. The commissioning results shall be documented on a standard test running and maintenance record or equivalent as provided by the associated Refrigeration Systems Manufacturer and offered to the Clerk of Works upon request. The record shall form part of the Operating and Maintenance document.

9.2 EQUIPMENT WARRANTY AND MAINTENANCE

The Contractor shall supply all the specified equipment complete with three years warranty on both materials and labour commencing on satisfactory hand over of the complete installation.

9.3 REFRIGERANT PIPEWORK

All pipe work installed on refrigeration systems shall be refrigerant quality copper. Plastic or steel will not be acceptable under any circumstances.

All refrigeration pipe work shall be installed by specialists in accordance with BS EN 378 : 2000. The refrigeration pipe work will be installed and sized in standard sizes stipulated by the air conditioning unit manufacturers.

The refrigeration specialist shall be responsible for the sizing and routing of all refrigerant pipe work in accordance with the general principles shown on the drawings.

All refrigeration pipe work internally and externally shall generally be run on galvanised steel tray.

Where pipework is exposed in rooms it shall be run in white PVC trunking with stop ends to conceal pipework and cabling

Allowance must be made for expansion of pipe work on long runs.

Copper tubes shall be to BS: 2871, Part 2 ASTM B280-8, DIN 8905, DIN 1754, seamless and solid drawn and flow tested by the eddy current method (non destructive test).

9.4 PIPEWORK INSULATION

Insulation shall be Armaflex or similar class "O" fire rated and vapour sealed. Insulation and vapour seal shall be continuous through supports. Minimum wall thickness shall be 15mm. For applications where the suction temperature is -5°C or below minimum wall thickness will be 25mm.

All external Armaflex insulation exposed to sunlight and UV radiation shall be protected using Armafinish FR paint applied strictly in accordance with the manufacturer's recommendations. It is important to ensure that the correct coverage rate is applied to give the proper thickness of coating. A minimum of 2 coats will be required. Paint not to be applied whilst insulation is in-situ.

All exposed pipework within occupied areas shall be run in white PVC trunking.

9.5 INSTALLATION TECHNIQUES

All tube for refrigeration purpose shall be capped at all times other than when actually being installed. It is imperative that the inside of the tube is kept free from dirt and moisture at all times.

No copper tube for refrigeration purpose shall be cut using hacksaw or any tool which creates filing which will contaminate the system. All jointings made on the refrigeration system, are to be brazed or flared. Flared joints will only be accepted on components inserted within the system such as sight glass, drier, solenoid valve and only when 5/8" or below, on proprietary items supplied such as compressor, condenser etc.

When brazing is being carried out oxygen free nitrogen should be passed through the pipe work to displace the oxygen within the pipe work to ensure that no oxidation takes place.

The pipe work will be joined to the air conditioning units by a flared connection.

Brazing should be carried out by a skilled operative in accordance with HVCA code of practice.

Where pipe work is externally installed it should be clipped using hydrozorb anti vibration clips fixed to return flange cable tray of a suitable size and where the possibility of mechanical damage is evident a secondary cable tray should be fixed over the pipework to provide protection against damage.

All in-line shut off valves shall be of ball type, constructed in brass and copper and shall meet the requirements of AN51 code B16-35.

Driers, sight glasses etc. (where required) will be obtained from a recognised manufacturer (sporlan or similar) and will be installed with regard to manufacturers recommendations.

9.6 PIPEWORK DESIGN

This shall be carried out in accordance with the requirements dictated by the manufacturer within their technical manuals, or advised by the distributor. Refrigeration pipe work will be installed in standard sizes stipulated within the manufacturers standard technical specification.

9.7 TESTING AND EXECUTION

The entire refrigeration system shall be pressure tested at 4 bar using oxygen free nitrogen and refrigerant.

Leak checking shall be carried out by the halide torch or similar if the system fails to hold its pressure over 24 hours.

Once the system has passed the pressure test the nitrogen/refrigerant mix should be recovered and the vacuum pump placed on the system. All parts of the system on the low and high side should be open to the vacuum pump. To achieve this it may be necessary to evacuate from more than one point system.

Once the system has achieved a vacuum of 2 torr the system should be left on the vacuum pump for 24 hours if possible. After this time the gauges should be closed and the vacuum pump disconnected. The system should hold one torr for an hour. After this time the system may be charged, taking care not to allow air into the system.

9.8 IDENTIFICATION

Refrigeration pipe work shall be labelled generally as follows:-

- RX Gas Line
- RX Liquid Line

When X is the refrigerant number used

External condensers shall be labelled with room(s) and equipment served. Labels shall be traffolyte.

9.9 CONDENSATE

The Contractor shall design, supply and install condensate drainage systems to serve the cooling systems.

The condensate lines shall generally follow the routes taken by the refrigerant pipe work or as otherwise indicated on the relevant drawings. The condensate drains shall be formed using solvent glued UPVC rigid plastic tube in accordance with the manufacturers standard technical specification and shall be with gravity fall where practically possible

The Contractor shall include for providing a pumped condensate drain if required from the indoor split units. The drains shall be trapped and routed as indicated on the drawing to discharge into an adjacent waste pipe via a tundish and glass trap with filling point.

All condensate pipe work shall be thermally insulated and labelled accordingly.

9.10 FRESH AIR

The Contractor shall design, supply and install fresh air systems as required to meet Building Regulations and this specification.

Duct work etc. shall be as the relevant section.

9.11 OPERATING CONDITIONS

External plant shall normally be sized and operate between -5°C and $+35^{\circ}\text{C}$.

External plant shall be sited to avoid extremes in temperature and recycling of air.

9.12 REMOVALS

Prior to removal of refrigeration equipment the systems shall be degassed and the refrigerants safely stored before being sent to a recognised site for recycling or safe disposal.

Removal of air conditioning and ventilation shall include removal of all associated supports, insulation, fixings, fittings, controls etc.

9.13 ELECTRICAL WIRING INSTALLATION

The Contractor shall allow within his tender for all interconnecting control wiring for the split and systems including the wiring between the fan coil and remote controllers

The Contractor shall provide all relevant information required by the Electrical Contractor to ensure the correct operation of the systems as detailed in this specification, schedules and drawings.

9.14 EQUIPMENT HEAT OUTPUTS

The Contractor shall determine heat loads from room data sheets, design meetings and for comms from the attached table

SECTION 12

WASTE PIPE SYSTEMS

12.1 UPVC PIPE WORK AND FITTINGS

The pipes and fittings shall comply in all respects with the following British Standards:

- BS 4515 'Unplasticised PVC Soil and Ventilating Pipe, Fittings and Accessories'
- BS 5255 'Plastic Waste Pipe and Fittings'
- BS 3943 'Plastic Waste Traps'
- BS 2494 'Materials for Elastometric Joint Rings for Pipe Work and Pipelines'

Pipes shall be supplied in plain ended lengths

The minimum acceptable wall thickness of pipe and fittings shall be as follows:

75mm Pipe	3.18mm	75mm Pipe	3.43mm
100mm Pipe	3.18mm	100mm Pipe	3.43mm
150mm Pipe	3.30mm	150mm Pipe	3.68mm

The method of jointing to be employed shall be that of solvent welding using the manufacturers approved cement. Seal ring joints shall be used where necessary to accommodate thermal movement.

The grade of polymer used for the pipe shall have minimum softening point of 82EC and for the fittings a minimum softening point of 79EC when tested by the Vicat method as described in British Standards BS 2782.

Pipes and fittings shall be of colour grey except for exposed connections to sanitary ware which shall be colour white.

Fittings for connections of branch waste and ventilating pipes shall consist of waste bosses fitted to pipe or integral moulded boss adaptors on fittings. Alternatively, connections may be solvent jointed to branch fittings utilising sockets reducer fittings where necessary.

Branch soil pipe connections to WC pan outgo, or similar soil appliance outgo, shall consist of miltikwik or similar and approved flexible connector jointed into plain end UPVC pipe.

Holderbats shall be made of mild steel protected from corrosion by galvanised, or plastic coating. They shall have a two position fixing suitable, either as a pipe support allowing thermal movement, or as a clamp fit on a fitting creating a fixed point.

Vent pipes passing through the roof shall terminate with a neoprene / aluminium weathering slate, weathering collar and a balloon grating.

12.2 HIGH TEMPERATURE PVC WASTE SYSTEM

Pipes are to be supplied plain ended and all fittings to be socketed both ends. The minimum acceptance wall thickness for pipes to be as follows:

32mm	(1.91mm)
40mm	(2.03mm)
50mm	(2.16mm)

All pipes and fittings to comply with the Code of Practice recommendations.

The method of jointing to be employed shall be that of solvent welding using the pipe and fittings manufacturers approved cement. Seal ring joints shall be introduced where it is necessary to accommodation expansion.

The grade of polymer used for the pipe shall have a maximum softening point of 100EC when tested by the cantilever method as described in British Standards 2782 Method 102C.

All waste fittings shall have a minimum softening point of 80EC kilogram 'Vicat' method as described in British Standards 2782 Method 102C.

All pipes and fittings shall be to colour grey British Standard 1660 /1 1055 Grade 9.100.

Traps should be moulded from white polypropylene. The fittings will comply in all respects to British Standards.

The complete waste system when assembled and installed in accordance with the manufacturers instructions shall be capable of satisfactory standing up to the tests laid down in BS 4514 : 1969 Section 13, elevated temperature cycling requirements and therefore passing the system test as laid down.

The system shall be installed to accommodate thermal movement between fixed points by installing expansion joints. Expansion joints shall be fitted if the fixed points are greater than 1m apart, or in long straight runs without fixed points, at a maximum 4m apart. Expansion joints shall be made by using selected fittings as indicated on the drawings and fitted in the direction of flow as marked on the fittings.

The pipes shall be fixed in straight runs and all horizontal runs are to be laid to gradients un accordance with Code of Practice, but in any event not less than 1 in 48 unless otherwise instructed.

The installation, method of jointing and fixing shall comply in all respects with the manufacturers fixing instructions.

Access rodding eyes shall be provided at the end of all PVC floats and generally at any changes of direction. Access to the end of PVC floats shall be via access tees. All access eyes are to be as fixed in an accessible position.

12.3 CONNECTIONS TO SANITARY FITTINGS

The soil pipes or waste pipes to the various sanitary fittings shall be of the following sizes:

- | | |
|---|---|
| • Wash Basins | 50mm dia. waste pipe, with 36mm self-resealing bottle traps |
| • Sink and Washing Machines and Dishwashers | 50mm dia. waste pipe, with 40mm tubular traps |
| • Showers | 50mm dia. waste pipe, with 40mm tubular traps |
| • Baths | 50mm dia. waste pipe, with 40mm tubular traps |
| • Floor Grilles | 100mm dia. waste pipe, bottom outlet, with 100mm dia. tubular “P” trap with access to bottom below slab |
| • Planting Area | 50mm dia. waste pipe, with tubular ‘running’ trap 100mm dia. soil pipe with pan connector |

The term ‘sanitary fitting’ shall include all kitchen and laundry equipment that requires plumbing services.

12.4 UPVC PIPE WORK INSTALLATION

The installation, method of jointing and fixing shall comply in all respects with the PVC manufacturers site work instructions.

Solvent welded joints shall be made using the manufacturers approved cement.

Seal ring fitted shall be used where necessary to accommodate thermal movement, or the sockets of standard fittings shall be converted to seal ring joints by the addition of a seal ring adaptor.

As seal ring expansion joint shall be provided in each length of pipe work that is fixed at both ends and exceeds 1 metre long, and where possible this expansions joint is to be formed by using an expansion joint fitting at one end of the pipe work (for example, by using an expansion boss connector at a boss, or by using an adaptor to convert a welded socket of a fitting into a seal ring socket). Where the length of the pipe work exceeds the distance stated below, intermediate expansion coupling shall be inserted to divide the pipe work up into length that do not exceed that distance:

- Pipes up to and including 50mm size – 1.8 metres
- Pipes over 50mm size – 3.6 metres

In addition, where a branch / boss connection is made to a stack at a level that is more than 500mm from a fixed point on the stack, an expansion joint shall be provided between the branch / boss connection and the foxed point.

Fixed points on pipes shall be considered to be where they pass through, or connect at, floor and roof slabs, at all welded branch joints, and any other welded joints except straight couplings and bends.

Cut ends of PVC pipes shall be formed square with a fine toothed saw and then made smooth. For solvent welding joints, the pipe shall be pushed fully in against the shoulder of the socket and for expansion joints the end of the pipe shall be chamfered and set back 12mm from the shoulder of the socket. In both cases, the pipe shall be marked beforehand to demonstrate that the correct penetration has been achieved.

Joints between PVC pipe and other materials shall be made with the fittings and the jointing materials recommended by the PVC manufacturer.

PVC caulking bushes solvent welded to PVC pipe size 50mm or less, or ring seal polypropylene caulking brushes, shall be used for connection to metal or non-metal caulking sockets (including socket reducer as required) with tarred gaskin at one third socket depth and PC4 or similar cold caulking compound firmly caulked home into the remaining socket space.

Joining PVC pipe to clay ware drain pipe spigot terminals shall comprise insertion of PVC pipe into the clay ware pipe system polypropylene adaptor.

PVC pipes shall be fixed so that they are supported to provide thermal movement, with all expansion coupling anchored to prevent movement, with brackets supplied by the PVC pipe system manufacturer. Such fixings shall be provided wherever necessary to locate and stabilise the pipe work in correct alignment and to uniform gradient and in addition shall be at the maximum spacing shown as follows:

PVC Pipe Size	Vertical Pipes	Horizontal Pipes
38mm (1.1/2")	1.2 metre	0.5 metres and below
50mm (2")	1.2 metre	0.9 metres
75mm (3")	1.8 metre	0.9 metres
100mm (4")	1.8 metre	0.9 metres
150mm (6")	1.8 metre	1.9 metres

Brackets supporting PVC pipe work from walls shall be galvanised or plastic coated mild steel.

Suspended pipe work shall be supported with galvanised or plastic coated mild steel pipe brackets with bolted or screwed connection to galvanised or similar rust proofed screwed drop rod hanger secured through the slab with a 100mmx 6mm tick mild steel drilled back plate and nut at structured slab level, or screwed into an expanding anchor socket fixed in the concrete soffit, including back nut, unless shown otherwise on the Tender Drawings.

Supports on 50mm suspended pipe size and above shall permit thermal movement of the pipe barrels and shall securely clamp and real ring expansion sockets.

Where drop rod hangers over 300mm long support expansion sockets the bottom of the drop rod shall be braced back to the concrete soffit with a bracing rod of angel section at 45E and parallel with the pipe longitudinal axis fitted with anchor bolt or similar to the soffit. Alternatively, thermal movement limiter (TML) brackets as

manufactured by Key Terrin Ltd, or approved equivalent, with vertical drop rod hangers as described shall be used to 100mm and 150mm pipe size.

Additionally, to pipework suspended at more than 300mm below soffit and where branch pipework exceeding 2 metres length joints the main run, the junction supports shall be cross braced either side of the vertical hanger at right angles to the main pipe longitudinal axis of resist thermal movement from the branch pipe.

12.5 CAST IRON SOIL PIPES AND WASTE PIPES

The pipes and fittings shall comply in all respects with the following British Standards:

- BS 416 'Cast Iron Spigot And Socket Soil Waste And Ventilating Pipes And Fitting'
- BS 437 'Cast Iron Spigot And Socket Drain Pipes And Fittings'
- BS 6087 'Flexible Joints For Cast Iron Pipes And Fittings described in BS 416 And BS 437'
- BS 2494 'Materials For Electrometric Joint Rings For Pipework And Pipelines'

Where possible pipes shall be supplied socketless in plain ended lengths (on all spigot system) with flexible coupling. Where this is not possible, spigot and socket pipework with caulked joints will be acceptable with the approval of the Engineer.

For pipes and fittings above ground floor slab level, the minimum wall thickness of pipes and fittings shall be to BS 416, with a minimum wall thickness of 5mm for all sizes from 50-150mm. The material shall be manufactured by sand cast or spun process and shall be to BS 1452 : 1977 Grade 150 or better.

For pipes and fittings below ground slab level, running at high level in basement car park areas or at high level in service ducts, the minimum wall thickness of pipes and fittings shall comply to BS 437 and shall be as follows:

100mm Pipe	8.0mm
150mm Pipe	9.0mm
225mm Pipe	13.0mm

The material shall be manufactured by sand cast or spun process and shall be to BS 1452 : 1977 Grade 150 or better.

Pipework shall be jointed using flexible coupling, manufactured from top quality cast iron to BS 1452 : 1977, with nitrile rubber gaskets to BS 2494 and stainless steel nuts and bolts to BS 970.

12.6 CAST IRON PIPEWORK

The installation, method of jointing and fixing shall comply with all aspects with the Cast Iron Pipework Manufacturers Site Work Instructions.

Pipework shall be supported using two piece mild steel holderbat type brackets with stainless steel bolts.

Supports shall be at 3.0m centres on vertical runs of pipework (all sizes) and at 1.8m centres on horizontal pipework.

Supports shall be fixed to walls using an expansion type fixing with bolt. Shot fired bolts shall not be used to support pipework. Holes for expansion anchors shall be drilled. The expansion bolt shall be 'set' by driving it into the hole and expensing it with either a threaded rod or bolt.

Suspended pipework shall be supported with galvanised steel or cast iron brackets with galvanised screwed drop rods fixed using with expansion bolts (as above) with backnuts, or secured through the slab to 100mm x 100mm x 6mm thick mild steel drilled backplate and nut at structured floor level.

Where drop rod hangers over 300mm long support the pipe the bottom of the drop rod shall be braced back to the concrete soffit with a bracing rod or angle section at 45E, parallel with the pipe longitudinal axis and field with an expansion bolt or similar to the soffit. If a branch pipe jointing the main run exceeds 2m in length the junction supports shall be cross braced with side of the vertical hanger at right angles to the main pipe longitudinal axis to resist thermal movement from the branch pipe.

12.7 SYSTEM ACCESS

Access points shall be provided to facilitate rodding through, inspection and testing of the pipework.

Access points shall be installed near the base of all stacks, at changes of pipe direction in the vicinity of or an all stack branches at each story, on the up-steam end of common branch waste pipes, on the top of stub pipe up-stands and elsewhere indicated on the drawings and defined by BS 5572.

Access points shall always to positioned above floor level of sanitary appliances unless it is impractical to do so, and they shall be orientated so as not to obstructed by the structured or pipework and such access points shall be correctly relate to removable panels in order to facilitate ease of removal of the access plates, rodding through and replacement of the access.

All in-line access doors shall be contoured to match the pipe bore.

Metal or plastic rectangular or oval type access doors shall be fitted with brass or other rust-proofed fixing bolts / screws and soft rubber gaskets.

Copper pipe end access shall comprise copper or copper alloy screwed cap fitting and plastic pipe end access consist of plastic screwed cap fitting, all compete with sealing washers.

Floor gullies shall be installed as indicated on the drawings. Gullies and gratings shall be of approved pattern as scheduled on the drawings.

The installation, method of jointing and fixing shall comply with all respects with the manufacturer's instructions.

Floor gullies shall be sealed firmly and securely supported by the slab / deck / floor construction.

It is essential to ensure that gullies are free from obstruction / debris for fitting gratings and any gullies left in position prior to fitting the grating shall be temporary sealed or plugged or prevent ingress of debris.

12.8 OVERFLOWS

WC cistern overflow and water heating cistern overflows shall be of 22mm UPVC pipe as indicated on the drawings.

Overflows shall terminate through an external wall, at low level over a drained toilet floor or over a gully as indicated.

12.9 PIPEWORK SLEEVES

Where pipework passes through walls or floors a sleeve of suitable diameter shall be fitted. Sleeves for PCV pipes shall be plastic, copper or galvanised mild steel of close tolerance pattern.

Where a PVC pipe of 40mm diameter or greater passes through a fire compartment wall or floor (as defined in Section B 2, 3, 4 Appendix F of Building Regulations) pipework shall be sleeved with a proprietary and approved sealing system such as DUFAYLITE in intumescent sleeves. Appropriate test certificates shall be submitted to the Engineer for approval before commencement of the works.

All sleeves shall finish with the finished surface and oversize sleeves shall be sealed with proprietary intumescent fire packing material in the annular space around the pipe.

The hole around all sleeves shall be in-filled with concrete fire-stop infillings.

12.10 ACCESS DOORS

Access doors shall be provided as required for all clean outs and other elements requiring access above ceiling or behind walls or as indicated in the drawings. The installation of all doors will be performed under the specification of other trades. The Contractor shall co-ordinate the work and assume responsibility of accessibility.

The door types, finishes and exact locations shall be as indicated on the Architects drawings.

12.11 SEALING PIPEWORK OPEN ENDS

Particular importance shall be placed upon the proper protection and sealing of open ends to pipework and fittings during construction.

All pipework open ends or open sockets or open fittings shall be properly sealed, plugged or capped during the progress of the works to prevent entry of building materials and debris.

Plastic, shaped hardwood or metal discs, plugs or drain plugs will be acceptable for this purpose. Screwed-up paper or cloth pushed into open ends will not be acceptable and shall not be used.

12.12 TESTING

The sanitary plumbing installation shall be air tested in accordance with BS 5572 Code of Practice of Sanitary Pipework, Section 12.

Air testing for soundness shall be carried out in sections as the works proceed to suit the progress of the building works, pipes to be concealed shall be tested before being enclosed, and final testing shall be carried out at completion.

The test shall be carried out by means of suitable air pressure equipment, the testing plug shall be fitted with a tee piece with a cock on each branch, one branch being connected by flexible tube to a monometer scale.

The pressure applied shall be equal to 40mm water gauge and shall remain constant for a period of not less than three minutes. All sanitary fitting traps shall be full charged and open end of pipework plugged during the period of the test.

All tests shall be recorded by the Contractor and shall be carried out in the presence of and to the satisfaction of the Engineer. The Contractor shall provide all necessary testing apparatus, equipment and fittings together with competent site operatives to carry out the works and reinstatement of pipework which fails to meet the requirements of the test, including retesting to the satisfaction of the Engineer at no extra cost to the Contract.

12.13 COMPLETION

At completion of the works the Contractor shall systematically flush through the pipework runs with clean water checking for water tightness at joints and freedom of obstruction within the pipes. Any suspect pipe runs shall be rodded through with flexible drain rods and re-flushed with water.

All protective coverings shall be removed from sanitary fittings and appliances which shall be cleaned and checked out to ensure that they function as intended.

All trap seals shall be charged with cold water and the whole of the sanitary plumbing installation shall be left in clean working order.

APPENDIX 1
DRAWING REGISTER

2050-RWA-XX-XX-DR-M-9401

Mechanical Services Roof As Proposed
Layout

2050-RWA-XX-ZZ-DR-M-9402

Mechanical Services Second Floor As
Existing and As Proposed Layout

APPENDIX 2

SCHEDULES OF EQUIPMENT

Ref Nº	Location	Model	Cooling Capacity (kW)	Heating Capacity (kW)	Dimensions w x d x h (mm)	Electrical Details (Fuse) (Ph)		Accessories / Comments
Internal Units								
IDU1	AMR Laboratory	SLZ-M50FA	4.42	4.25	650x650x245	6A	1	Cassette Unit c/w PAR-40MAA wall mounted hard wired controller. Cassette unit to be provided with SLP-2FA Grille.
External Units								
ODU1	Roof	SUZ-M50VA	-	-	840x330x880	20	3	
Notes								
1. Electrical Contractor to provide power to internal and external units. All control wiring, power wiring and containment from the external condenser to the internal units to be provided by the Mechanical Contractor. 2. All refrigerant pipework, condensate drains and electrical wiring to be installed on cable tray containment system. 3. Cooling and Heating figures indicate loads at design conditions.								
Manufacturer: Mitsubishi								
SCHEDULE: M1		JOB Nº: 3763		SHEET: 1 of 1			REV: P1	
AIR CONDITIONING UNITS								

Ref Nº	Location	Manufacturer / Model	Overall Size w x d x h (mm)	Required Duty		Electrical Details		Accessories / Comments
				(l/s)	(Pa)	(kW)	(Φ)	
HE1	AMR Laboratory	Nuaire XBoxer XBC+15	1600x1000x 260	160	180	3.34	Single	Unit to be controlled via integral Nuaire Ecosmart controllers and in room PIR Occupancy Sensor. PIR occupancy sensor with run-on timer. Filters to be accessible from underneath.
Notes: 1). All units to be monitored and controlled from the BMS.								
Manufacturer: Nuaire								
SCHEDULE: M2		JOB Nº: 3763		SHEET: 1 of 1			REV: P1	
SUPPLY & EXTRACT HEAT RECOVERY UNITS								

Ref Nº	Location	Manufacturer/ Model	Size [mm] w x l x h	Duct Size [mm] w x l x h	Volume [l/s]	PD [Pa]	Accessories / Comments
ATT/01	HE1 – Supply & Extract	Nuaire XBC15-HS-MS10 XBC15-HE-MS10	347+238 x 1050 x 220	250Ø	160	10	Max, allowable PD
ATT/02	HE1 –Extract	Nuaire XBC15-HE-MBS-L	406 x 852 x 260	250Ø	160	10	Max, allowable PD Bend Attenuator
ATT/03	HE1 –Supply	Nuaire XBC15-HS-MBS-S	515 x 515 x 260	250Ø	160	10	Max, allowable PD Bend Attenuator
Notes 1. System side silencers are to be sized to achieve NR35 @ 1.5m. 2. All revisions made in BOLD							
Manufacturer: Nuaire							
SCHEDULE: M3 JOB Nº: 3763 SHEET: 1 of 1 REV: P1							
ATTENUATORS							

[illegible]

[illegible]

Ref No	Location / System	Type	Duty		Speed (rpm)	Electrical Details		Comments
			(m³/s)	(Pa)		(kW)	(Ph)	
EF1	CSB1 Roof Plantroom AMR Lab Safety Cabinet	Colasit CMVeco 160	0.214	350	2200	-	3	Polypropylene fan To be provided with inverter by BMS provider