Specification

Centre for Ecology and Hydrology
E d i n b u r g h

Bush Estate
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EH26 0QB

Replacement Boiler Plant to External Plantroom

Revision 2 -17 May 2017

SPECIFICATION

CONTENTS

SECTION 1

PRELIMINARIES

CEH EDINBURGH
EXTERNAL PLANTROOM REPLACEMENT BOILER PLANT

CONTENTS

1.1 Definitions

The following definitions shall apply to this specification: -

Mechanical Engineering Contractor (MEC) – 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 Engineering Contractor shall equally refer to the Mechanical Sub-Contractor or Building Services Sub-Contractor.

Electrical Engineering Contractor (EEC) – 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 drawing etc. Depending upon the type of contract the term Electrical Engineering 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 Engineering Contractor or the Electrical Engineering Contractor to complete a part of the works on their behalf, the Building Services Contractor, Mechanical Engineering Contractor or the Electrical Engineering Contractor shall be fully responsible for all works undertaken by the specialist.

Engineering Contractor – Where this term is used it shall refer equally to the Mechanical Engineering Contractor and Electrical Engineering 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 Sub-Contractor, Mechanical Engineering Contractor or Electrical Engineering Contractor.

Consulting Engineer – Refers to a client representative

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

1.2 General

This document shall be read in connection with all other documents issued as part of this contract. The MEC shall comply with the relevant sections of the Client's Main Contract documents including any Preliminaries issued by and/or to the Client.

The MEC shall be responsible for obtaining these documents.

1.3 Standards and Regulations

The whole of the engineering services shall be designed, selected, erected, inspected and tested in accordance with the latest versions of all Statutory Obligations arising from current legislation and regulations, all applicable regulations, standards and common accepted good design and construction practices.

Some of the key standards are listed below: -

- Asbestos at Work Regulations and amendments
- British Standards and Codes of Practice
- Building Regulations (or Scottish Building Regulations where applicable)
- CIBSE, B&ES and I.E.T. Guides, technical memoranda, codes and other such documents
- Clean Air Act and Clean Air Regulations
- Construction (Design and Management) Amendment Regulations
- Control of Pollution Act
- COSHH Regulations
- Department of Health guidance (HBN< HTM etc.)
- Electricity at Work Act and Electricity at Work Regulations
- F-Gas Regulations
- Gas safety Regulations
- Health and Safety at Work Act
- HSE approved codes of practice and other guidance notes.
- IEC Standards
- IEE Wiring Regulations (BS7671)
- Institute of Plumbing - Plumbing Engineering services design guide, together with other such technical memoranda and codes of practice
- Insurance Company Requirements
- LDSA Fire Safety Codes
- Liquid petroleum Regulations
- London Building Act and / or Building (Inner London) Regulations where applicable.
- Pressure Regulations
- Public Utility Company and/or Statutory Authority regulations, specifications, and requirements.
- Water Regulations

- Health and Safety (Display Screen Equipment) Regulations

The MEC shall notify all authorities in accordance with their regulations and obtain any required approvals for the installation.

The MEC shall ensure that all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed at the same location.

Any deviation from the above industry standards or equivalents will be accepted, though the MEC must demonstrate full compliance.

1.4 Approved Contractors

The MEC must be able to demonstrate reasonable competence and experience of carrying out work of a similar scope, value and complexity, and must be able to fully resource the necessary skills and labour to carry out the works.

The MEC shall be approved by a recognised body and confirmed in writing to the Consulting Engineer. Generally this recognised body shall be NICEIC for Electrical Contractors (Commercial) and Safe Gas and B&ES for Mechanical Contractors.

In addition, the MEC will be required to successfully complete the Client's approval and tendering processes. Please contact the Client for details of these criteria.

1.5 Sub Letting

The contract for the works shall not be sub-contracted, in whole or in part, without the written permission of the Consulting Engineer.

The MEC shall state on his tender return documentation the names of all companies to whom he proposes to sub-let portions of the works. Approval of the sub-letting by the Consulting Engineer shall not relieve the MEC of any of his obligations under his contract. The MEC shall be responsible for the programming and execution of all the works sub-let.

1.6 Site Visit

The MEC shall visit the site during the tender period and before commencement of the works and shall be held to have satisfied himself and to have made due allowances for local conditions, the nature and accessibility of the site, nature and extent of operations, the supply of and conditions affecting labour, the storage space for materials, position of underground services and drains, the nature of the ground, space for execution of the works generally, and the full extent of stripping out requirements.

1.7 CDM Regulations

The MEC shall be responsible for all matters regarding the Construction Design & Management Regulations (CDM) for his designs and operations including consideration for future demolition, adaptation and extension.

Before commencement of site the MEC shall provide the following: -

- Three copies of Method Statements and Risk Assessments for dealing with specific operations, i.e. lifting of major plant, working at height, working in confined spaces, break-ins to existing services etc.
- Three copies of Health and Safety information as required by the Regulations for incorporating into the project Health and Safety file.

1.8 Tender Submission

Tenders will only be considered if the Tender Summary Sheet given in Section 4 is submitted with each and every element completed. Grouping of costs will not be accepted.

1.9 Schedule of Rates

Prior to the acceptance of any tender, the MEC shall be required to provide a fully quantified schedule of rates, based upon the tender costs submitted, for all the works required under the contract. This shall be provided within five working days of the request. This information may be requested from all tendering contractors.

The Schedule shall detail quantities and rates for all works to include separate breakdowns for labour, materials, overheads and profit and in accordance with the Standard Method of Measurement current edition, authorised by agreement between the Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers.

The Schedule shall be fully priced and totaled to the original tender price. It shall be used only for the pricing of variations and

establishing valuations.

In the event of any discrepancy in the Schedule, the quantities and/or rates shall be corrected as necessary but the total sum shall not be amended as a result.

1.10 Interim Claims / Valuations

Interim claims shall be made showing itemised breakdowns of the total values only of work done and unfixed materials on site 7 days before the date when application is to be made for an interim payment. Claims shall only include goods or materials owned by the claimant, and this shall be confirmed on each interim claim submitted. Interim claims not confirming titlement of goods will not be certified.

Where fluctuations are allowed under this Contract these shall be included in a separate document and submitted monthly with the interim claim. The document shall provide all support information including time sheets signed by the Contractors site agent, supplier's invoices, price lists, index calculations, as applicable.

1.11 Variations

Variations shall only be carried out under the written instruction of the Consulting Engineer. Any instructions given verbally on site should be followed up with confirmation in writing. Variations shall not be carried out under the instruction of any other person.

When materials and equipment which are not included in the Schedule of Rates are required to be provided under a variation, included with the estimate for the variation shall be a copy of any quotation received from suppliers and shall show separately the allowance required for overheads and profit. If a price list is used in place of a quotation, the date and reference of the price list shall be stated.

Written notice shall be given whenever it is considered that the regular process of the works, or of any part thereof, has been, or is likely to be, materially affected by the variation. A detailed estimate of the delay shall be submitted within 21 days where this affects the completion of this section of the Works. Should this affect other Works or the overall completion date, a further estimation of the delay shall be submitted.

1.12 Day works

Additional works carried out outside of the contract, or in addition to the contract, shall be done based on the schedule of rates provided before the contract was awarded.

No work shall be undertaken at day work rates without written approval. Day work sheets shall be signed at the time by the Clerk of Works or other approved personnel and submitted in triplicate with detailed schedules supporting the claim at the end of the week following that in which the work has been executed. The signing of day work sheets by the Clerk of Works or other person shall not of itself constitute authorisation of the work.

The labour rates which will be allowed will be those which are current at the time when the work was performed. They will be strictly net at Union Rates and shall be agreed with the Consulting Engineer before work commences.

1.13 Outside Working Hours

The MEC shall allow in their price for the full amount of any work that may be required outside normal working hours.

The MEC shall allow for additional hours and/or outside working hours in order to maintain progress in accordance with the contract programme.

Work shall only be carried out in outside hours if agreed with the Client and Consulting Engineer.

1.14 Final Account

The final account shall be delivered as soon as possible after issue of the Taking-Over Certificate. No accounts shall be authorised that are received after the expiration of 6 months from the date stated in the issue of the Taking-Over Certificate unless otherwise stated.

The final account shall only include the contract sum as applicable less any Prime Costs, Provisional Sums or Contingency Sums where applicable but including all variations and instructions agreed during the construction of the Works and confirmed in writing. Where fluctuations are allowed under this Contract, these will have been agreed monthly with the interim claims and shall be listed separately.

Only those items listed above will be allowed in the final account.

1.15 Value Added Tax

The tender shall be VAT exclusive.

Notwithstanding that, services and materials, whatever their nature, supplied by a nominated or Sub-Contractor to a Contractor are taxable at the standard rate: the MEC shall provide all reasonable assistance to the Client to enable him to determine the value of those supplies of services and materials which attract (1) a zero rate of tax, and (2) any rate of rates of tax other than zero.

1.16 Co-ordination

The MEC shall be responsible for coordination the entire M&E Services works.

All details indicated on the drawings are for tender purposes only and shall be verified on site by the MEC where accuracy is critical. The exact location of all plant items/equipment and the route of all services shall be determined on site. The successful MEC shall, on being awarded the project, be required to provide working coordinated drawings for review by the Consulting Engineer within five working days of receipt of order.

The final positions of all plant, services and controls shall be approved by the Client and/or Consulting Engineer prior to installation.

The MEC shall allow for changes in distribution system(s) invert levels (including any sets up and down etc.) as necessary to coordinate fully with the building structure and other M&E Services.

The MEC shall prepare working drawings for comment and review by the client team prior to procurement of sub-contract work, plant etc., and prior to works commencing on site.

1.17 Installation Liaison

The MEC shall attend such meetings as necessary to enable him to co-ordinate the services installation with other Sub-Contractors and trades.

1.18 Services Integration

The MEC shall allow for connection to other services as required in order to facilitate full and complete intended operation of all systems.

1.19 Contract Programme

The MEC will be required to prepare a master programme and progress chart to clearly indicate how the work is to be carried out to completion within the period of the Contract. This programme shall be co-ordinated with ALL other trades.

No claims will be considered if the MEC's agreed programme is at variance with any programme given in the tender documents.

As soon as possible and before starting work on site the MEC shall prepare a programme for the works which must make allowance for the following: -

- Delivery and positioning of main plant items
- Sub-Contractors work
- Running in, adjustment, commissioning and testing of all engineering services and installations
- Demonstration of the completed works to the end user
- Work by or on behalf of the Employer
- Work resulting from instructions issued in regard to the expenditure of provisional sums.

1.20 Safety

The MEC shall be responsible for his own safety, and the safety of others, as required by all current legislation, codes of practice and guidance notes. In particular, the guidance given by the Health and Safety Executive shall be adopted at all times.

Work people shall not trespass beyond the limits of their work.

1.21 Materials and Workmanship

The work shall be carried out by suitably skilled tradesmen under the supervision of a competent foreman in a manner consistent with good engineering practice and to the reasonable satisfaction of the Consulting Engineer.

1.22 Tender Drawings

The drawings provided as part of this tender package are to give an indication of the intended work required and are to be used to assist in submitting a price for the works.

The drawings provided with this tender package are indicative. The information contained therein is intended to show what is required from the MEC. The details of how some work may be done shall be determined by the MEC during further site investigations. Any detailed work proposed by the MEC shall be sufficient to facilitate the full and proper intended operation of the systems.

The MEC shall ensure that all services are carried out as intended on the drawings provided. Failure to carry out the installation as detailed on the drawings and in this specification will not be tolerated**.**

1.23 Working Drawings

Before work commences the MEC shall submit a full set of working drawings for approval. This shall be done immediately and without delaying start on site. The Consulting Engineer shall require 10 working days to review and comment on the drawings, after which any amendment shall be made without affecting programme.

When approval of drawings is given, this shall signify only general approval in principle to the arrangement(s) shown and will not relieve the MEC of his responsibilities for discrepancies, errors or omissions in the drawings, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished to him in accordance with the Conditions of Contract.

The working drawings shall be produced using the latest version of AutoCAD software.

CAD drawings can usually be provided to assist in the preparation of working drawings. The cost for providing these should be obtained by the MEC at tender stage.

The Contractor shall produce the following drawings: -

1.23.1 Detailed Design Drawings

Drawings showing the intended locations of plant items and service routes, in such detail as to indicate the design intent. The main features of detailed design drawings should be as follows: -

- Plan layouts to a scale of at least 1:100.
- Plant areas to a scale of at least 1:50 and accompanied cross sections. The drawing will not indicate the precise position of services, but it should be feasible to install services within the general routes indicated. It should be possible to produce co-ordination drawings or installation drawings without major re-routing of the services.
- Represent pipework by single line layouts. Represent ductwork by either double or single line layout as required, to ensure that the routes indicated are feasible.
- Indicate on the drawing, the space available for major service routing in both horizontal and vertical planes.

1.23.2 Coordination Drawings

Drawings showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of a co-ordination drawing are as follows: -

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- A spatially co-ordinated drawing i.e. no physical clashes between the system components where installed at the scaled off positions shown on the drawing. Provide dimensions in areas where tolerances are minimal.
- Make allowance for the service at its widest point for spaces between pipe and duct runs. Allow for insulation, standard fitting dimensions and joint widths on the drawing.
- Make allowance for those plant items specified by the designer and identified in the design specification.
- Make allowance for installation working space and space to facilitate commissioning and maintenance.
- Indicate positions of main fixing points and supports where they have significance to the structure design.
- Arrange the services so that it is possible to demonstrate a feasible sequence of installation. Support the drawing with individual service drawings for clarity.
- Plantroom layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20.

1.23.3 Installation Drawings

Drawings based on the detailed design drawing or co-ordination drawing with the primary purpose of defining that information needed by the tradesmen on site to install the works. The main features of installation drawings should be as follows: -

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- A spatially co-ordinated drawing i.e. no physical clashes between the system components where installed at the scaled off positions shown on the drawing.
- Make allowance for the inclusion of all supports and fixings necessary to install the works.
- Make allowance for the service at its widest point for spaces between pipe and duct runs. Allow for insulation, standard fitting dimensions and joint widths on the drawing.
- Make allowance for installation details provided from shop and manufacturers drawings.
- Make allowance for installation working space, space to facilitate commissioning and space to allow on-going operation and maintenance in accordance with the relevant health and safety requirements.
- Make allowance for plant and equipment including those which are chosen as alternatives to the designer's specified option.
- Provide dimensions where the positioning of services is considered to be important enough to leave the tradesmen on site.
- Plantroom layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20.

1.24 Manufacturer's Recommendations

All materials and products shall be handled, stored and fixed in accordance with the manufacturer's recommendations. Any conflict with other specified requirements shall be reported. Copies of the manufacturer's recommendations shall be submitted to the Consulting Engineer when requested.

1.25 Samples for Approval

Where approval of products is specified, the MEC shall supply samples, or other evidence of suitability, for the Client and Consulting Engineer to approve. Orders shall not be confirmed or materials used until approval has been obtained. Approved samples shall be retained on site for comparison with products or materials used, and shall be removed when no longer required.

Where samples of finished work are specified, approval of stated characteristic(s) shall be obtained before proceeding. Approved samples shall be retained on site for comparison with the finished work, and shall be removed when no longer required.

1.26 Dimensions

Site dimensions shall be taken in preference to scale. Working and detail drawings shall be taken in preference to small scale plans differing from them.

The MEC shall take his own dimensions for both tendering purposes and execution of the works, and shall be responsible for the accuracy of such dimensions and drawings made therefrom.

1.27 Builders work

The MEC shall carry out all builders work in connection with the works detailed herein. These works shall generally consist of, but shall not be limited to, the following: -

- Temporary protection of the building finishes and fixtures during the installation and commissioning works.
- Making good the building fabric, including weatherproofing where necessary, after stripping out of the existing redundant services and installation of the new services.
- Carry out all wall chases and making good thereof.
- Carry out any penetrations through walls, floors & ceilings and making good thereof.
- Cleaning of the working area after each shift where the area is to be occupied or used by the End User.

1.28 Supervision of Labour

The MEC shall ensure that a fully qualified and competent person is constantly present on site during the execution of the works. This person shall not be changed at any point without the agreement of the Consulting Engineer.

Trade custom in the employment of the appropriate grades of work people shall be followed.

1.29 Site Staff

The Consulting Engineer reserves the right to have removed from site any person he deems not to be suitable to be on the contract. The removal of such persons shall not be considered to affect the contract in any way, including programme. It shall be the MEC's responsibility to have them replaced with suitable staff if required.

The process of removing a person from site will usually follow an initial warning (written or verbal) unless the Consulting Engineer considers it necessary for immediate removal without warning.

1.30 Site Conduct

During the contract all persons on site shall adhere to the manner of which the Client requires.

The following list gives examples of the sort of conduct that will not be tolerated on site: -

- Inappropriate language
- Radios
- Shouting
- Inappropriate manner
- Smoking, in or around the site (unless locations have been prior agreed with the Client).
- Unsuitable clothing
- Slogans that may offend
- Lack of suitable clothing

Vehicles shall only be left in areas prior agreed with the Client. The number of vehicles allowed on site shall also be agreed.

1.31 Client Confidentiality

The Client's right to confidentiality shall be respected at all times. Information obtained on site shall not be circulated.

1.32 Deliveries to Site, Off-Loading and Installation

The MEC shall be responsible for the supply, delivery, off-loading, positioning and installation of all plant and materials as detailed in this specification and indicated on the tender drawings. This shall include the provision of all necessary craneage (including any associated hard standing), lifting tackle, trolleys, skids, ladders, gangways, fences, temporary workshops, tools, scaffolding other than that already erected etc., and the removal of same upon completion.

The strength of floors where heavy loads are to be stored, or where such loads are to be moved across, shall be checked in good time before the load is applied so that if the strength of the floors is deemed to be inadequate, arrangements for supporting the load can be made without delay to the programme.

The storage locations of all plant and materials shall be agreed with the Client. In any case, the storage locations shall not hinder site access routes, escape routes or cause delay and/or disruption to other trades.

The MEC shall arrange for his delivery of materials so that no congestion occurs and shall include for all additional handling and transporting due to site conditions.

The MEC shall be responsible for rectifying any damage caused by the off-loading, positioning and/or installation of his plant and materials, including any sub-let works.

1.33 Protection of Materials and Work

Plant and materials stored on site shall be supported clear of the ground and shall be suitably protected against the weather. In addition, all pipe, conduit and trunking shall be stored in suitable racks.

All plant and materials, whether fixed or unfixed, shall be protected against the ingress of dirt or moisture, particularly into working parts, by means of securely fixed polythene covers or similar.

1.34 Access Equipment

The MEC shall provide all the necessary access equipment required for the supply, delivery, off-loading, positioning and installation of all his plant and materials, including any sub-let works.

1.35 Site Storage and Office Accommodation

The MEC shall provide all necessary site storage facilities and office accommodation for his works, including any sub-let works. The positions of any such facilities shall be prior agreed with the Client.

It should be noted that storage space on site may be restricted and the MEC shall include for the fullest cooperation with the Client in the use of available storage space. Plant and materials already delivered and stored may require relocation prior to final positioning and the MEC shall make due allowance in his contract costs for such eventualities.

1.36 Site Cleanliness

The MEC shall allow for cleaning up and carting away all his own rubbish, and any of his Sub-Contractors' rubbish, as it accumulates during the progress and upon completion of the works. All working areas shall be shall be left in a clean and tidy condition.

1.37 Disruption and Noise

The use of noisy mechanical tools or equipment shall only be permitted by prior arrangement. Should any request for such be declines or specific instructions be issued that such noise cannot be accepted, this decision shall be accepted and alternative arrangements made at no additional contractual cost.

1.38 Free Issue Equipment

The MEC shall allow for the installation, fixing and/or connection to equipment supplied by others. It is the MEC's responsibility to obtain all the information required in order to complete the above.

1.39 Existing Services

Any work carried out on or around existing services shall be done without ANY disruption to the Client.

Isolation of any services, for connection of new, adaptation or the like, shall be done at a time to suit the Client and shall be accompanied by a method statement submitted for approval at least 10 working days before planned works.

The MEC shall allow for disconnection and removal of any redundant plant and materials from site in a manner that is in full compliance with the Local Authority, Utility Company and Client requirements. Certificates of safe disposal shall be provided where necessary.

All Items of equipment no longer required as part of the new proposals shall be listed and presented to the Client for consideration for retention for spares etc.

1.40 Testing and Commissioning

The MEC shall carry out all necessary testing and commissioning works in order to provide the Client with a fully working installation. Commissioning shall include the seasonal commissioning of all works.

All commissioning shall be carried out in such a manner as to minimise operating costs for the end user whilst fully complying with the design intent of the systems.

An adequate period of time shall be allowed to carry out the testing and commissioning works, after completion of the building works and works of other trades. The MEC shall ensure that this period of time is not reduced.

All testing and commissioning shall be witnessed and approved by the Consulting Engineer.

All commissioning shall be carried out in accordance with the CIBSE Commissioning Codes and BSRIA commissioning requirements. Where there is a difference or contradiction between these documents, the MEC shall be deemed to have included for the more onerous and rigorous, as defined by the Consulting Engineer.

Any water, fuel and energy required for testing and commissioning of the installations shall be provided by the Client.

1.41 Site Power and Lighting

The MEC shall allow for the supply and installation of all equipment required to facilitate their works. The source of connection shall not be assumed to be from the Client unless agreed in writing. Generators shall not be used unless agreed with the Client and Consulting Engineer.

1.42 Temporary Lighting

The MEC shall be responsible for providing general lighting and task lighting.

The installed permanent lighting system(s) shall only be used for site lighting purposes with the agreement of the Consulting Engineer, providing that the luminaire diffusers are not installed and all lamps used being replaced prior to handover. All lamps used for temporary lighting shall be marked before installation.

Any energy, supervision and insurance required for this purpose shall be provided by the Client.

1.43 O&M Manuals

The MEC shall provide a comprehensive Operation and Maintenance (O&M) manual, incorporating as-installed drawings and manufacturer's literature.

The MEC shall employ a specialist Sub-Contractor to produce 4 No. complete copies of the Operating and Maintenance manuals. The manuals shall cover the full scope of the services installed by the MEC and appointed Sub-Contractor(s), including any additional works installed during the contract period.

The manuals shall be produced in accordance with Class D of BSRIA Guide BG I/2007 "Handover, O&M Manuals and Project Feedback – A Toolkit for Designers and Contractors", unless stated otherwise.

The manual shall provide the following sections and details as a minimum: -

- Bound in covers capable of withstanding continual heavy use.
- An Index
- Helpful telephone numbers
- Instructions for dealing with emergency conditions for each plant
- All information to enable operational staff to comprehend fully the extent, purpose and method of operation of the plant(s) including a full description of operation
- Detailed schedules of all plant and equipment installed, including model numbers, serial numbers and capacities and with reference numbers which agree with the detailed labelling strategy agreed with the Consulting Engineer.
- Schedule of manufacturers' names, addresses and telephone numbers
- Detailed instructions on the starting up, running and shut-down of all systems
- Description of operational routines, together with diagrams showing the functions of all controls
- Clearly set out the extent and frequency for which maintenance is required, in detail, and how it should be carried out
- Maintenance and lubrication schedules listed in order of frequency.
- Information to facilitate the ordering of spares and replacements
- Common fault finding measures and remedial actions
- Any precautionary measures necessary to prevent corrosion or freezing etc.
- Care required of plant which is or may be subject to seasonal or occasional use
- A final copy of the report(s) prepared during testing and commissioning, including all test certificates.
- Maintenance information may be supported in detail, but not replaced, by maintenance instructions provided by the suppliers of equipment and/or plant
- The instructions shall provide a complete and co-ordinated package
- A full set of Record or 'As Fixed' Drawings
- Particular attention shall be paid to the location and depth of buried services including those installed by Gas, Water and Electricity Authorities etc.

The Sub-Contractor employed to carry out the production of the manuals shall be a current Corporate Member of the Commissioning Specialists Association.

The as-fitted drawings shall be produced using the latest version of AutoCAD software. A CD shall be provided with each manual, containing all as-fitted drawings. The CD shall also contain a copy of the O&M manual in .pdf (Adobe Acrobat) format, including all manufacturers' literature and test and commissioning data.

Drawings for assistance in the preparation of as-fitted drawings can usually be obtained from the Consulting Engineer. The cost for providing these should be obtained by the MEC at tender stage.

1.44 Piped Services Schematics, Valve Charts and Labels

A schematic drawing of each piped service (i.e. LTHW Heating, Domestic Services, Natural Gas, Compressed Air etc.), shall be provided in each plantroom where that service is contained. Each schematic shall accurately detail the as-built pipework arrangement, including all associated plant, controls equipment and other ancillaries. Each drawing shall also detail the following: -

- Basic design criteria (water temperatures, operating conditions etc.)
- Piped services materials (type of tube and fittings)
- Valve schedule (listing valve reference, pipe description (i.e. boiler primary circuit etc.), line size, valve manufacturer, valve model reference and valve size).
- Commissioning valve schedule (listing valve reference, design flow rate, pipe description (i.e. boiler primary circuit etc.), line size, valve manufacturer, valve model reference and valve size).

Each drawing shall be mounted in a glazed frame and shall be fixed in the room to which it refers. The framing method shall ensure no degradation of the drawing or frame from the environmental conditions which could be reasonably expected within the room it is mounted. All drawings shall be of sufficient size to be clear and legible. Sample drawings, and details of the drawing framing, shall be provided to the Consulting Engineer for approval.

Traffolyte labels shall be neatly fixed to the valves concerned and shall be screwed or bolted on as necessary. As an alternative fixing method, chrome plated ball chain would be acceptable. Each label shall be at least 40mm diameter, with legible and clear lettering (at least 15mm height), corresponding with the markings on the drawing(s). The label and lettering colours shall be of contrasting colours, i.e. black lettering on a white background. A sample copy of the valve label type shall be provided to the Consulting Engineer for approval.

1.45 Labelling of Plant and Equipment

Each item of plant and equipment shall bear a metal nameplate giving the manufacturer's name, serial number and relevant plant and equipment performance data. This nameplate shall be provided by the manufacturer at their works.

In addition, traffolyte labels shall be neatly fixed to all items of plant and equipment, and shall be screwed or bolted on as necessary. Each label shall be at least 65mm long x 40mm high, with legible and clear lettering (at least 10mm height), corresponding with the markings on the drawing(s). The label and lettering colours shall be of contrasting colours, i.e. black lettering on a white background. The data contained on each label shall correspond accurately with the Schedule of Plant and Equipment in the O&M manual. A sample copy of each label type shall be provided to the Consulting Engineer for approval.

1.46 Completion and Handover

When, in the opinion of the Consulting Engineer, the installations are complete, with all accessories, components, spares and tools provided; that all testing, commissioning and instruction has been satisfactorily completed and that all O&M manuals have been provided, a recommendation will be made to the Client to take over the installations.

A Certificate of Taking Over will be issued by the Consulting Engineer following the official handover of the works to the Client.

1.47 Demonstrations

The MEC shall allow in their price for sufficient time to demonstrate and train the Client and end users on all items within the installation.

Any specialist equipment shall be demonstrated by the manufacturers or specialist installers. It is the MEC's responsibility to ensure that all costs are covered for outside assistance. A suitable time with sufficient prior notice shall be agreed with the Client, Consulting Engineer and any other parties involved.

1.48 Defects Liability

The MEC shall provide a minimum of 12 months cover from the date of Practical Completion for all work and equipment unless otherwise stated in the 'Particular Requirements' of these documents.

Shall it become necessary to replace or renew elements of the works under this clause, the provision thereof shall apply to the element so renewed or replaced until the expiration if 12 months from the data of such replacement or renewal.

Variations from the above shall only occur if it is agreed by the Consulting Engineer that the defect is as a result of influences outside of the MEC's control.

1.49 Pressure Regulations Documentation and Compliance

The MEC shall provide all certification/documentation in compliance with the Pressure Equipment Directive (97/23/EC) and all latest amendments.

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

Failure to provide necessary certification shall render the equipment/system non-functional. The MEC shall be liable for any subsequent costs associated with the non-compliance.

The entire installation shall comply in full with the Pressure Regulations.

The MEC shall include: -

- Provision of all safety relief valves and the like.
- Provision of individual pressure test certificate for all components covered by the regulations (type testing is not acceptable).
- Provide (or update an existing when modifying a system) a written scheme of examination in accordance with the regulations, employ a competent person to complete this on the MEC's behalf if this cannot be completed in house.

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

In addition, the MEC shall provide sufficient information to enable the End User to operate and maintain all pressure systems in full compliance with the Pressure Systems Safety Regulations 2000.

SECTION 2

GENERAL REQUIREMENTS

CONTENTS

2.1 PIPEWORK INSTALLATIONS

2.1.1 Introduction

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

The works shall be to the requirements of the Contract documents and to the satisfaction of the Contract Administrator or his representatives

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

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

2.1.2 Standards

All pipework shall be installed in accordance with the current editions of all applicable BS/EN and CIBSE/B&ES/HVCA/BSRIA standards, the most notable of which are listed below. These shall be a guide to the MINIMUM standard required and shall be overridden by the standards referred to in the rest of this specification and associated drawings.

- CIBSE Guides
- Current Scottish Government's Technical Handbooks
- Current Pressure Regulations
- ESTTL Certification to Appendix I of TR/5 (HVCA)
- HSE Guidance - Legionella
- HSE GS4
- HSE L56 ACOP – Gas Safety
- HVCA TR documents
- Institute of Gas Engineers IGE/UP publications
- TMV3 Thermostatic Mixing Valve Specification
- Water Regulations
- BSRIA AG1/2001.1
- BS 21 ISO / 7, BS EN 10226 & BS EN ISO 228
- BS 143
- BS 316 & DVGW W541
- BS 1224
- BS 1256
- BS 1710
- BS 2633
- BS 2971
- BS 4504
- BS 6700
- BS 6798 & BS 6644
- BS 7671
- BS EN 1211, BS 2035 & BS 4775
- BS EN 1024 Part 1
- BS EN 1057
- BS EN 1415 Part 2
- BS EN 1515 & BS EN 1092
- BS EN 5588
- BS EN 10216
- BS EN 10217
- BS EN 10253
- BS EN 12236
- BS EN 12327
- BS EN 13501

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

Any deviation from the above industry standards or equivalents will be accepted, though the MEC must demonstrate full compliance.

2.1.3 Local Water Authority Registration and Compliance

The MEC shall be a "Licensed Plumber" with Scottish Water. All operatives shall have undergone all necessary training and the MEC shall provide certificates of competence before completing any work on domestic water or incoming water service systems.

The MEC shall issue all water services (domestic and external services etc.) working drawings to the local authority for their comment with regard to water regulations and local requirements (except where the MEC is able to self-certify the scheme with the local authority).

The MEC shall agree with local authority all tests and certification required by the water authority before connection of the water supply to the building.

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

The MEC shall ensure that all systems fully comply with the local water authorities particular requirements.

2.1.4 General Installation Requirements

Pipework shall be arranged to follow the contour of walls and other structural lines and all vertical pipework shall be plumb, without off-sets and set as close as possible to any local projects consistent with maintaining adequate clearances for the installation of wall, floor or ceiling plates or insulation.

Pipework shall be graded to ensure adequate draining and venting.

Except where necessary for the operation of the system, all pipework lines shall run parallel to one another.

During construction of the works the MEC shall take all reasonable care to prevent foreign matter entering pipework. All open end of pipework shall be temporarily capped with appropriate pipework fittings.

2.1.5 Common Requirements – Steel Pipework

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

Mild steel pipework shall: -

- Be heavy grade seamless tube (except when using proprietary system such as Geberit Pressfit).
- Be supplied with standard works anti-corrosive lacquer finish.
- Be stainless steel on overflows, vents and drains (or alternatively copper).
- Minimum size pipe to be employed on any part of the circulating system shall be 15mm.
- Jointing shall be: -

Threaded connections on LTHW and CHW pipework, shall be allowed on systems with a working pressure less than or equal to 7 bar (gauge) for 65mm diameter pipework and below.

Threading of 65mm pipework shall only be used where this does not compromise the system in terms of the required working / test pressure and operating temperature.

Welded connections shall be used in all other cases.

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

- Blank ends shall be formed using welded cap ends on pipework 32mm diameter and below, flanges shall be used in all other cases.
- All branches shall be formed utilising proprietary fittings, branches welded in square or welded shoes shall not be used.
- All threads shall be taper type; parallel shall only be used to match control valves and the like where taper threads are not available.

2.1.6 Steel Pipework - Welding

Welding Certificates acceptable to the Consulting Engineer are: -

- Steam pipework – Class 1 welding.
- Hospital/Health Projects, all services apart from steam – Class II welding.
- All services elsewhere up to 16 Bar(g) and within the temperature range -20°C to +220°C, ESTTL certificate.
- All services above 16 Bar(g) Class I welding

Supervision/Quality Control: -

- The MEC shall ensure that the standard of workmanship is fully in accordance with the standards set out in the specified welding standard/certificate.
- The welder's individual mark shall be stamped adjacent to each weld.
- A copy of the certificate, individual mark and date of issue shall be issued to the Consulting Engineer for each welder employed on the project prior to each welder commencing work on site; copies shall also be included in the O&M manuals.
- Any weld without an individual mark shall be tested by non-destructive testing, then marked by HVCA inspector (or cut out and remade) all at the MEC's own expense.

Non-Destructive Testing shall: -

- Be completed outside normal working hours or when site/area is unoccupied for health and safety reasons.
- Be completed by an independent HVCA / Insurance approved inspector to the standard matching the specified welding certificate.
- Be radiographic/ultrasonic as suitable, determined by inspector.
- The decision of the inspector shall be binding on the MEC at no additional cost to the contract.
- The following levels of testing shall be included for at tender stage and carried out during the installation: -
  - Steam, MTHW, HTHW 100%
  - Buried services 100%
  - All other services 5%
- Any production welds failing tests shall be repaired or replaced and a further 5% of welds tested, further failures shall require 100% of welder's work to be tested and made good all at Contractors own expense.

Welding particulars: -

- Building protection using appropriate materials shall be provided to prevent scorching and fire damage.
- Where electric welding is employed the Client's supply shall not be used, either temporary power or suitable (power/noise/emissions) generator provided.

2.1.7 Common Requirement – Copper Pipework

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

Copper pipework shall: -

- Be chromium plated after mock up assembly when exposed to view in toilets/tea points etc.
- Minimum size pipe to be employed on any part of the circulating system shall be 15mm.
- Jointing shall be: -

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

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

Compression fittings shall only be used on final connection to equipment and valves where no alternative is available (i.e. Ballofix valves) excluding steam condensate systems.

- Joints in inaccessible locations shall be avoided. Should this not be possible, written permission shall be obtained from the Consulting Engineer and brazed joints shall be employed.
- Lead free solders shall be used for soft soldered joints.

2.1.8 Press Fit and Express Fit Systems

This shall apply to the following systems: -

- Geberit Mapress galvanised steel
- Geberit Mapress stainless steel
- Yorkshire Express Fit copper.

When using the above systems the MEC shall: -

- The manufacturer's proprietary system components shall be used along with approved components such that the full manufacturer's warranty is fully maintained. (E.g. Yorkshire Express Fit shall only be used with Yorkshire pipework).
- Not be used for final connection to plant / equipment, except connections to sanitaryware.
- Be installed fully in accordance with manufacturer's written instructions.
- Take account of the increased requirements for expansion / contraction using natural flexibility.
- Be of a minimum pressure rating of PN16.
- When offered as an alternative the system resistance shall not be increased, the MEC shall include for increased pipe sizes as necessary.
- Ensure that the following is included for and provided by the manufacturer: -
  - All fitters to have attended manufacturer's training course and have appropriate current certification.

  - Site progress inspections with written inspection reports and details of corrective action / comments to be completed by manufacturer own engineers.
  - Site completion inspections with written inspection report and details of corrective action / comments to be completed by manufacturer own engineers.
  - 25 year installation and materials warranty provided by manufacturer - project specific certificate to be provided.
- Off-site fabrication shall be employed to the maximum extent; on site jointing shall be the minimum necessary to connect prefabricated sections.
- Each joint shall be marked with the fitter's individual symbol / initials corresponding with a key included in the O&M manuals to allow quality monitoring of jointing process. Any joints not permanently marked shall be cut out and replaced.
- Manufacturer's storage recommendations shall be meticulously complied with due to increased susceptibility of these systems.
- In areas of high humidity, externally and wherever moisture may be in contact with the system (e.g. chilled water etc.) the manufacturer's recommendations with regard to additional corrosion protection such as anti-corrosion tape to fittings shall be complied with in full.
- Condition of specialist jointing tools and jaws / terminals etc. shall be continuously monitored and replaced in accordance with manufacturer's recommendations.
- Only manufacturers own seals / O-rings etc. shall be used, where a choice of material is offered this shall be selected to give the maximum life for the system as a whole (e.g. butyl rubber rather than PTFE).
- Connections to valves and equipment shall be completed in accordance with the fitting / pipework manufacturer's recommendations using preparatory fittings wherever they are available.
- When installed in confined spaces and voids the manufacturer's minimum recommended spacing around the services shall be provided to enable future connections and repairs to be undertaken without removing adjacent services etc.
- Supports for the pipework system shall: -
  - Be the manufacturer's purpose designed support system incorporating pipe carriers.
  - Be suitable for the expansion / contraction system employed.
  - Prevent stress on joints, particularly when connecting to risers & equipment.

2.1.9 Pipework Clearances

Pipework shall be installed in order that the minimum clearances as noted below are maintained between the pipework, or pipework insulation where fitted, and the adjacent surface(s).

- Walls: 25mm
- Ceilings: 100mm
- Finished floor: 150mm, or 50mm above top of skirting, whichever is greater
- Below raised floor: 100mm minimum AFFL
- Adjacent pipes, both insulated: 150mm
- Adjacent pipes, both un-insulated: 150mm

Notwithstanding the minimum clearances noted above the MEC shall allow sufficient space to facilitate the easy applications of pipework insulation.

2.1.10 Pipework Supports

All pipework shall be adequately supported. Supports shall permit free movement for expansion or contraction of pipework and shall be located to ensure that pipework branches or fittings are not fouled by the supports during expansion or contraction of the pipework.

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

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

Each pipe support shall: -

- Be arranged as near as possible to joints.
- Take its due proportion of pipe and components weights.

- Allow for expansion and contraction.
- Support the pipework via rollers, chairs and flat iron stirrup guides as appropriate.
- Meet any structural constraints imposed by the Structural Engineer.
- Details of all types and makes of brackets and fixings to be used shall be given to the Consulting Engineer prior to ordering or manufacturing and his comment obtained.

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

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

All insulated services shall be provided with proprietary insulated pipe supports.

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

Maximum Intervals Between Pipework Supports (m)														
Nominal Size (mm)	Steel – Heavyweight		Copper		Steel – Grooved		Pressfit – S/S and Galvanised		Express Fit - Yorkshire Copper		Ductile Spun Iron		PE	
Orientation	H	V	H	V	H	V	H	V	H	V	H	V	H*	V*
≤16	2	2.5	1.2	1.5	2	2.5	1.5	2	1.2	1.5	2	2.5	0.2	0.3
≥17 and ≤23	2	2.5	1.5	2	2	2.5	2	2.5	1.5	2	2	2.5	0.3	0.5
≥24 and ≤29	2.5	3	1.5	2	2.5	3	2.2	3	1.5	2	2.5	3	0.5	0.8
≥30 and ≤36	2.5	3.5	2	2.5	2.5	3.5	2.5	3.5	2	2.5	2.5	3.5	0.7	0.8
≥37 and ≤43	3	4	2.3	2.5	3	4	3	4	2.3	2.5	3	4	0.8	1
≥44 and ≤55	3.5	5	2.5	2.8	3.5	5	3.5	5	2.5	2.8	3.5	5	0.9	1.1
≥56 and ≤68	4	6	2.7	3	4	6	4	6	2.7	3	4	6	1	1.2
≥69 and ≤81	5	7	2.9	3.3	5	7	5	7	2.9	3.3	5	7	1.1	1.4
≥82 and ≤109	6	10	3	3.5	6	10	6	10	3	3.5	6	10	1.2	1.6
≥110	7	12	3.3	3.8	7	12	7	12	3.3	3.8	7	12	1.3	1.8

Notes: H = Horizontal, V = Vertical

* Refer to manufacturer's specific installation instructions for additional support locations to suit jointing method.

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

2.1.11 Cutting of Pipework

All pipework cutting shall be completed in accordance with both the pipe and fitting manufacturer's recommendations using proprietary tools where required.

All pipework shall be cut clean and square with the axis of the pipe (or bevelled edge as required for welding) using a saw, pipe cutting tool or machine.

All pipework shall be prepared by filing or grinding and all internal burrs shall be removed by filing or reaming.

Any lubrication used during cutting shall be in accordance with both the pipe and fitting manufacturer's recommendations.

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

2.1.12 Malleable Iron Fittings

All malleable iron fittings shall be of the banded type, black or galvanised to match pipework material.

For reductions and enlargements, easy transition type with inclined angle not exceeding 30 degrees shall be used.

All bends shall be of the long sweep pattern, centreline radius/nominal bore of not less than 1.5.

Where the use of a long sweep fitting would throw the pipework beyond an acceptable distance from the wall when exposed in rooms, short radius fittings can be used after first obtaining the acceptance of the Consulting Engineer.

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

The use of segmented or cut and shut bends or fittings shall not be permitted.

2.1.13 Tees, Branches and Twin Elbows

All tees, twin elbows and crosses shall be of the easy sweep pattern.

On gauges, test points, air venting devices and drain cocks, square pattern shall be used.

On sensors, square pattern shall be used, unless stated otherwise by the manufacturer’s instructions.

Unequal tees shall be used in preference to equal tees with separate reducing fittings. The use of bushes shall not be permitted. Unequal tees shall be eccentric pattern on horizontal pipework and concentric on vertical pipework.

2.1.14 Unions

All unions shall generally be of malleable iron with two bronze seats, as the Navy pattern. For galvanised pipework, unions shall be galvanised. For copper pipework, unions shall be gunmetal.

Unions shall be fitted on the outlet of each screwed valve where installed, except in the case of draw-off points.

Where pipework is provided with screwed joints the MEC shall allow for providing sufficient unions in the running lengths of the pipework to ensure that the pipework can be readily dismantled, if required, at a later date.

2.1.15 Flanges

All flanges shall be provided on all services for ease of maintenance and for mating to valves, equipment etc. Selection of the appropriate flange type, material and specification shall be in accordance with the relevant British Standards and shall: -

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

2.1.16 Valves

Wheel or lock shield valves and stopcocks shall be fitted where indicated on the drawings and as detailed elsewhere in this section of the specification.

Each screwed valve shall be fitted with a union adjacent to facilitate maintenance.

Valves installed underground shall be complete with a cast iron surface access box indicating service of valve.

2.1.17 Stopcocks

Where exposed in rooms, all stop cocks on the hot and cold water services shall be of gunmetal, chromium plated easy clean type. All other stopcocks shall be of standard pattern.

2.1.18 Draincocks

All drain cocks shall be 15mm unless stated otherwise. All draincocks shall be complete with serrated hose connection to retain a rubber hose and an operating spindle fitted with a renewable ‘O’ ring gland.

In voids, risers and plant rooms, draincocks shall be oblique (or 'Y') renewable washer screw down type of gunmetal or bronze construction.

Where exposed to view, draincocks shall be lockshield type, where fitted to chromium plated or polished stainless steel tube, drain cocks shall have a chromium plated finish.

Drain cocks shall be fitted within 75mm of the floor and be in accordance with the Water Regulations.

Draincocks shall be fitted in the following locations: -

- Where indicated on the drawings.
- As detailed in specific sections of this specification.
- At all low points on all water systems to ensure complete drainage.

2.1.19 Commissioning and Balancing Valves

Commissioning valves shall be supplied and installed in the pipework systems to allow full and proper balancing of the water distribution systems.

Commissioning valves shall be fitted in the following locations: -

- Where indicated on the drawings.
- As detailed in specific sections of this specification (Whether indicated on drawings or not)
- Generally on the return of each heating / cooling circuit (Primary & Secondary)
- Generally on the return of each heating, cooling and recovery batteries.
- Generally on the return of each refrigeration machine chilled water evaporators and condensers.
- All major plant items e.g. boilers etc.
- All mains and sub-mains leaving plantrooms or main risers.

Commissioning and balancing valves shall either be combined (i.e. orifice plate plus DRV close coupled) or discreet (orifice plate on flow with DRV on return). All fixed orifice commissioning sets shall be selected to provide an accuracy of measurement of +/- 5% of design flow rate.

Venturi measurement devices shall be used where an accuracy better than +/- 3% of design flow is to be achieved.

Where specifically allowed in writing by the Consulting Engineer, variable orifice plates may be used on less critical circuits where accuracy shall be at least +/- 10% of design flow.

The maximum velocity through commissioning set shall be 1.2m/s up to 50mm diameter, 2.0m/s for 65mm diameter and above.

Measurement component shall be installed to the manufacturer's recommendations, subject to a minimum of 5 pipe diameters of straight pipe upstream, 3 pipe diameters downstream (whichever is the most onerous requirement).

All commissioning valves shall be selected such that excessive closing of the valve is not necessary for correct regulation, utilising smaller diameter valves than the adjacent pipework as necessary. The MEC shall include for necessary reducers within their tender. The MEC shall obtain excess pressures and design flow rates from designer prior to ordering commissioning sets.

All commissioning valves shall be selected such that they provide sufficient signal for accurate measurement (say 1-4.7Kpa), low flow units shall be used where necessary to achieve good readings.

Where no specific size is indicated, line size commissioning valves shall be included at tender stage. The final size shall be selected when accurate flow rates and pressures are known. The valves sizes shall be confirmed with the Consulting Engineer prior to ordering.

2.1.20 Air Eliminators

Air Eliminators / Air Bottles shall be provided as indicated upon the Tender drawings.

Air Eliminators / Air Bottles shall also be fitted at all high points on all water systems to ensure complete venting where self-venting through the mains or taps cannot take place or would not prove satisfactory.

Heating and chilled water installations shall incorporate air bottles which shall: -

- Have a minimum of a 50mm square branch (or line size if greater) with a 50mm diameter air bottle of a minimum length of 250mm.
- Be complete with cap and 8mm brass needle type air cock or air valve where there is a risk of scalding.
- Where the air cock / valve is fixed out of reach (e.g. steps / scaffold etc. would be required to gain access) an 8mm bleed pipe shall be extended from the bottle which shall:

Terminate in an air cock / valve 1.4m above finished floor level.

Air cock / valve shall be located in a convenient but unobtrusive location.

In voids, risers, plantrooms etc. pipes shall be run in 'Heavy' quality mild steel tube with malleable iron fittings neatly run on the surface.

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

Domestic hot and cold water systems shall avoid the use of air eliminators wherever possible, by using top connections to mains and venting via taps. Where this is impossible air eliminators shall be used as a last resort and shall: -

- Be complete with check valve and lockshield isolation valve for maintenance purposes.
- Have a minimum of a 50mm square branch (or line size if greater) with a concentric reducing socket to 15mm connection.
- Be complete with a 15mm automatic air vent; from the outlet of which an 8mm copper pipe shall be run to the nearest foul drain point.
- Terminate via a tundish arrangement to a trapped waste or over a gulley suitable to accept pipework discharges without obstructing access for cleaning and rodding.

2.1.21 Dial Thermometers, Pressure, Altitude and Vacuum Gauges

All Gauges shall be provided as indicated upon the Tender drawings, and shall comply with the following:-

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

Dial thermometers shall: -

- Be of the vapour pressure type with brass bulb.
- Have a black finished steel case and chromium plated bezel.
- Direct mounted gauges shall be flangeless.
- Panel mounted dial thermometers shall be either black or front flanged to suit either surface or flush mounted panel arrangements. Capillary tube dial thermometers shall have plain bulbs with either loose pockets or flanges to suit the mounting arrangements.

Pockets shall: -

- Be filled with heat conducting grease.
- On domestic water systems installed in a bend with the pocket facing into the fluid flow.

Pressure, altitude and vacuum gauges shall: -

- Be of the bourdon gauge tube type with BSP male thread.
- Be fitted with a bronze lever handle gauge cock with BSP female thread ends and a chromium plated finish.
- Have a 'U' or ring siphon interposed between the gauge and cock and the tapping point, and where practical fitted adjacent to the latter.
- The siphon on steam lines shall be formed from steel tube and shall be filled with water prior to the gauge being put into service.

Capillary tubes shall: -

- Be of correct length (excess shall be no more than 300mm and shall be neatly coiled and fixed).
- Have armoured flexible sheath.
- Have radius bends not less than recommended by the manufacturer.
- Be routed for minimum risk of damage. The route shall be agreed with the Consulting Engineer.
- Be clipped to cable trays provided by the MEC.

2.1.22 Test Points

Test points shall be provided as indicated upon the Tender drawings. All test points shall be of the Binder self-sealing type with screw down cap.

Test points shall be fitted before and after: -

- Pumps.
- Strainers.
- Coils.
- Emitters.
- Control devices such as valves.
- Plant items e.g. boilers, chillers etc.

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

2.1.23 Connections to Plant and Components

All connection to plant and components shall: -

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

2.1.24 Equipment Support and Protection

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

- Provided whether shown on the tender drawings or not.
- Be independent of the adjacent distribution systems (ductwork or pipework etc).
- Where supported from the floor, legs shall be mounted on a weight bearing upstand which extends at least 50mm above finished floor level in order to maintain floor finish integrity.
- Details of supports shall be supplied to both the Consulting Engineer for comment prior to manufacture.
- Supports shall be manufactured from steel, painted before erection, except when installed externally or in a damp environment where the supports shall be hot dip galvanised after manufacture.
- Where located on a flat roof support shall be provided by a specialist support system which shall: -

  - Bear weight onto the roof membrane without causing damage or undue stress.
  - Be located over structural members.
  - Meet the Structural Engineer's requirements.
  - Be manufactured by Roof-Pro Ltd (tel. 01234 843790) or equal and approved.
- Any exposed moving machinery (i.e. drives, belts, fan blades, chains, projecting set screws etc) shall be provided with protective guards which shall: -
  - Be manufactured from robust hot dipped galvanised welded steel open mesh within a welded galvanised steel frame.
  - Be easily removed for maintenance access.
  - Do not vibrate or transmit vibration to the building structure or equipment served.
  - To facilitate speed checks, removable bolted sections shall be provided opposite the shaft ends.

2.1.25 Anti-Vibration Mounting

Specialist anti-vibration mountings and flexible connections shall be designed and provided by the MEC to all items of rotating or vibration producing plant. These devices shall: -

- Be selected by the manufacturer making allowance for building structure, weight and characteristics of the equipment supported.
- Be of the laterally stable steel spring type mounting.
- In the case of small pumps (<1.500 l/s) neoprene mountings are acceptable.
- Limit vibration transmission to the structure, degree of isolation (vibration efficiency) shall be at least 95%.
- Final connections shall be via braided stainless steel flexible connections selected to match the anti-vibration mountings.
- Prevent any discernible re-radiated noise to adjacent rooms / areas either through the building structure or distribution systems.

2.1.26 Wall and Floor Sleeves / Plates

Individual pipe sleeves and plates shall be provided by the MEC and securely built in by the Building Contractor at all points where pipes pass through walls, ceilings and floors.

The pipe sleeves and plates shall be as detailed in HVCA TR documents and shall: -

- Have the space between the pipe and the pipe sleeve filled with proprietary non-setting fire stopping material.
- Not restrict expansion / contraction movement.
- On external walls be provided with a puddle flange.

The MEC shall be responsible to ensure that all pipe sleeves are correctly located both before and after building-in by the Building Contractor.

Where pipework is installed in exposed positions, chromium plated decorative plates shall be fitted at all visible points where pipework penetrates walls, floors or ceilings.

The plates shall be accurately and securely fixed in position on the pipework. Wherever an obstruction is encountered or wherever two plates overlap with one another the edges of the plates shall be neatly clipped or cut to either follow the contours of the obstruction or butt against one another.

2.1.27 Painting of Pipework

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

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

Gas pipework shall be painted with primer and two coats of gloss to comply with current gas regulations (yellow ochre).

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

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

Gas pipework shall be painted with primer and two coats of gloss to comply with current gas regulations (yellow ochre).

2.1.28 Identification of Pipework

All pipework, including services not insulated, shall be identified with colour bands in accordance with BS 1710.

All insulated pipework in exposed positions, and all pipework insulated or un-insulated in concealed positions, shall be identified at suitable intervals, at all valve or expansion joint positions, at inlet and exit positions to builder's ducts or buildings, and on both sides of walls or floors.

Each identification label shall be provided with the service description, pipe size and direction of flow.

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

2.1.29 Water Service Connections

All pipework, branches and final connections to all sanitary appliances shall be undertaken by the MEC. The final connections shall be carried out under this Specification by a qualified Plumber who is a member of Unite the Union or similar trade body.

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

2.1.30 Oil, Grease, Keys and Tools

At the termination of the work, the following keys and tools shall be provided by the MEC to the Project Manager, and shall also obtain a receipt for the same: -

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

In each plantroom where floor area exceeds 25m², the MEC shall provide a tool rack comprising of: -

- A set of spanners to fit each size of nut and bolt installed.
- All sizes of screw drivers and types employed.
- A pair of pliers.
- A set of keys for all vents, equipment etc.

2.1.31 Earth Bonding

The EEC shall be responsible for carrying out all required bonding as required by BS7671, On-Site Guide and all associated Guidance Notes, unless stated otherwise.

2.1.32 Manufacturers of Pipework Components

All components shall be manufactured and supplied by one of the manufacturers scheduled in the table below. All components of the same type shall be from the same manufacturer to ensure consistency across the project. Equivalent and compatible components will be acceptable though supplier needs to fully demonstrate compatibility with the specification.

Item	Description	Comments
Test points	Binder Crane / Hattersley Boss	
Differential pressure control and flow limiting valves	Oventrop Ltd Crane / Hattersley	
TRV's and corresponding lockshield valve.	Herz Danfoss Drayton	Adjustable Kv type (minimum six settings)
Air eliminators	Brownall	Type C
Air and/or dirt separators	Spirotech	
All others including isolating valves, commissioning stations etc.	Crane / Hattersley Oventrop Boss	
Expansion bellows	Engineering Appliances	Steam, HTHW, MTHW to be twin-wall stainless steel type with leak indication.
Anti-vibration equipment	TEK Ltd	
HWS thermal balancing valves	Crane/Hattersley RWC Oventrop	Dual temperature type to allow automatic change-over in pasteurisation cycle
HWS thermostatic mixing valves	Hansgrohe Mira Meynell Horne	TMV3
Steam & Condensate valves <75mm	Spirax Sarco Armstrong Peter Smith Ltd	
Steam & condensate valves >75mm	Spirax Sarco Hopkinson Ltd Peter Smith Ltd	
Steam components	Spirax Sarco Armstrong	
Steam isolating valves 80mm and above	Spirax Sarco Hopkinson Ltd Peter Smith Ltd	Parallel slide valves
Oil components	Oventrop	
Natural gas / LPG components	Oventrop	

2.1.33 Pipework Components – LTHW Heating and Chilled Water Service

The following components shall be used for MTHW Heating, steam and condensate services: -

Component Function	Size Range (mm)	Pressure Rating PN (minimum)	Valve Type	Component Materials	Notes
Isolation	15 – 50	16	GV or BV	DZR, GM, SS, BR, AM	
	65 – 200	16	GV or BFV	DZR, BR, GM, AM, SS, CI	See note 2
	250 and above	16	GV or BFV	AM, SS, CI	See note 3
Regulation	15 – 50	16	DRV	DZR, BR, GM, AM, CA, SS	
	65 – 200	16	DRV	DZR, BR, GM, AM, CA, SS	
	250 and above	16	DRV	DZR, BR, GM, AM, CA, SS	
Flow measurement and regulation	15 – 50	16	CS (DRV+OP)	DZR, BR, GM, AM, CA, SS	
	65 – 200	16	CS (DRV+OP)	DZR, BR, GM, AM, CA, SS	
	250 and above	16	CS (DRV+OP)	DZR, BR, GM, AM, CA, SS	
Check valve	15 – 50	16	NRV (gravity)	BR, GM, AM, SS	Low ΔP – 1kPa max.
	65 – 200	16	NRV (gravity)	BR, CI	Low ΔP – 1kPa max.
	250 and above	16	NRV (gravity)	BR, CI	Low ΔP – 1kPa max.
Orifice plate	All sizes	16	OP	SS, GM	
Strainer	15 – 50	16	STR	BR, GM, AM	See note 5
	65 and above	16	STR	GM, CI	See note 5
Union joints	15 – 65	16		MI, GM, SS	Navy pattern

Notes

1) All valves and components to be installed in strict accordance with the manufacturer's recommendations.
2) Butterfly valve – EDPM seat. Valve to be lever operated.
3) Butterfly valve – EDPM seat. Valve to be gearbox operated.
4) Wafer type check valves shall only to be used with the Consulting Engineer's approval. Low ΔP – 1kPa maximum. Pipework shall be arranged to ensure that operation of the check valve is not impeded in any way. Spacing shall be at least 6D upstream and 2D downstream.
5) Low ΔP – 2kPa maximum. Strainer complete with integral test points and stainless steel mesh cages.

Legend

ACoP	Approved Code of Practise
AM	Alloy developed for chilled water and cold fluid applications to resist corrosion.
BCWS	Boosted cold water service
BFV	Butterfly valve
BV	Ball valve
BR	Bronze
CHW	Chilled water service
CI	Cast iron
CS	Commissioning station (close-coupled, fixed orifice)
DHWS	Domestic hot water service
DI	Ductile iron
DRV	Double regulating valve

Legend

DZR	Copper alloy with inhibitor and heat treatment to prevent dezincification
GM	Gun metal
GV	Globe valve
HTHW	High temperature hot water
MCWS	Mains cold water service
MTHW	Medium temperature hot water
MI	Malleable iron
NRV	Non-return valve
OP	orifice plate
SS	Stainless steel
STR	Strainer
TCWS	Tank cold water service
WRAS	Water Research Advisory Service
DPR	Differential pressure regulator

2.1.34 Pipework Components – Domestic Services

The following components shall be used for Domestic Services (BCWS, DHWS, MCWS and TCWS): -

Component Function	Size Range (mm)	Pressure Rating PN (minimum)	Valve Type	Component Materials	Notes
Isolation	15 – 54	16	GV, BV	DZR, GM, SS	
	67 and above	16	GV, BFV	DZR, GM, SS	
Final connections to outlets for re-washering only	15 – 22	16	BV	DZR, GM, SS	See note 4
Regulation (see note 5)	15 – 54	16	DRV	DZR, GM, SS	
	67 and above	16	DRV	DZR, GM, SS	
Flow measurement and regulation	15 – 54	16	CS (DRV+OP)	DZR, GM, SS	
	67 and above	16	CS (DRV+OP)	DZR, GM, SS	
Check valve	15 – 54	16	NRV (gravity)	DZR, GM, SS, CI (lined)	
	67 and above	16	NRV (gravity)	GM, SS, CI (lined)	
Orifice plate		16		DZR, GM, SS	
Strainer	15 – 54	16		GM, SS	See note 6
	67 and above	16		GM, SS	See note 6
Union joints	15 – 54	16		GM	Navy pattern

Notes

1) All valves and components to be installed in strict accordance with the manufacturer's recommendations.
2) All components shall be Water Regulations and WRAS approved.
3) All ball valves installed on water services circuits shall have extended spindles to allow the application of insulation.
4) Full-bore, lever operated, chromium plated where exposed.
5) Lockshield valves shall only be used for flow regulation purposes with the Consulting Engineer's written approval.
6) Low ΔP – 2kPa maximum. Strainer complete with integral test points and stainless steel mesh cages.

Legend

ACoP	Approved Code of Practise
AM	Alloy developed for chilled water and cold fluid applications to resist corrosion.
BCWS	Boosted cold water service
BFV	Butterfly valve
BV	Ball valve
BR	Bronze
CHW	Chilled water service
CI	Cast iron
CS	Commissioning station (close-coupled, fixed orifice)
DHWS	Domestic hot water service
DI	Ductile iron
DRV	Double regulating valve

Legend

DZR	Copper alloy with inhibitor and heat treatment to prevent dezincification
GM	Gun metal
GV	Globe valve
HTHW	High temperature hot water
MCWS	Mains cold water service
MTHW	Medium temperature hot water
MI	Malleable iron
NRV	Non-return valve
OP	orifice plate
SS	Stainless steel
STR	Strainer
TCWS	Tank cold water service
WRAS	Water Research Advisory Service
DPR	Differential pressure regulator

2.1.35 Pipework Components – Natural Gas

The following components shall be used for natural gas services: -

Component Function	Size Range (mm)	Pressure Rating PN (minimum)	Valve Type	Component Materials
Isolation	15 – 50	16	BV, GV	DZR, BR, CI
	65 and above	16	BV, GV	DZR, BR, CI
Union joints	15 – 50	16		BR

Notes

1) All valves and components to be installed in strict accordance with the manufacturer's recommendations.
2) All components shall be Gas Regulations approved.
3) The first isolating valve on entry to a fire zone shall be Factory Mutual (FM) approved.

Legend

ACOP	Approved Code of Practice
AM	Alloy developed for chilled water and cold fluid applications to resist corrosion?
BCWS	Boosted cold water service
BFV	Butterfly valve
BV	Ball valve
BR	Bronze
CHW	Chilled water service
CI	Cast iron
CS	Commissioning station (close-coupled, fixed orifice)
DHWS	Domestic hot water service
DI	Ductile iron
DRV	Double regulating valve

Legend

DZR	Copper alloy with inhibitor and heat treatment to prevent dezincification
GM	Gun metal
GV	Globe valve
HTHW	High temperature hot water
MCWS	Mains cold water service
MTHW	Medium temperature hot water
MI	Malleable iron
NRV	Non-return valve
OP	orifice plate
SS	Stainless steel
STR	Strainer
TCWS	Tank cold water service
WRAS	Water Research Advisory Service
DPR	Differential pressure regulator

2.2 THERMAL INSULATION

2.2.1 Introduction

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

The works shall be to the requirements of the Contract documents and to the satisfaction of the Architect/Contract Administrator or his representatives (including the Consulting Engineer and Clerk of Works).

The MEC shall include for sub-letting the thermal insulation work to specialist firm, registered with the Thermal Insulation Contractors Association (TICA). The Specialist Insulation Sub-Contractor shall include for all materials, labour and other incidentals (e.g. off-loading, site storage etc), necessary to satisfactorily install and complete the insulation works.

The MEC shall state, at the time of tendering in the Specification Tender Analysis, the name of the Insulation Sub-Contractor who will carry out the work. Alterations/changes of Insulation Sub-Contractors, from those listed in the Tender Return, shall not be accepted without prior agreement by the Consulting Engineer and documented evidence giving reasons for change.

The thickness and finishes of insulation detailed within this Specification and the minimum standard acceptable. The requirements of BS 5750/ISO 9000 for achieving compliance with the Scottish Government's Technical Handbooks (current editions) shall be also be complied with. Should any discrepancies become apparent, the most onerous requirement shall be adhered to.

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

2.2.2 Scope of Work

This section describes the materials, coverings (including protective coverings) and installation applied to the engineering services. It excludes sound insulation, chimney, boiler or cold room insulation, and insulation of the structure.

These requirements will be specified elsewhere as/if necessary. Any insulation requirements not covered in this section shall be suitably marked up on the Contract drawings and/or specified elsewhere.

2.2.3 Standards

All thermal insulation shall be installed in accordance with the current editions of all applicable Scottish Government's Technical Handbooks (current editions), BS/EN and CIBSE/B&ES/HVCA/TIMSA standards, the most notable of which are listed below. These shall be a guide to the MINIMUM standard required and shall be overridden by the standards referred to in the rest of this specification and associated drawings.

- Current Scottish Government's Technical Handbooks
- BS 476
- BS 1710
- BS 3533
- BS 3927
- BS 3958
- BS 4508
- BS 5422
- BS 5608
- BS 5615
- BS 5588
- BS 5970
- BS 7523
- BS 7572
- BS 7671
- BS 8313
- BS EN ISO 12241
- NHS HTM Documents
- NHS Model Engineering Specifications
- TIMSA HVCA Guidance

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

Note: The environmental thickness tables in BS 5422 are specified by the DETLR as the basis of qualification for Enhanced Capital Allowances and as a means to comply with the Current Scottish Government's Technical Handbooks, Approved Document L (Conservation of Fuel and Power).

2.2.4 Temperature Assumptions

Unless stated otherwise, the temperature assumptions for both the ambient conditions and operating conditions of the fluid being conveyed shall be as stated in Table 2 of TIMSA HVCA Guidance: 2006.

2.2.5 Services to be insulated

Insulation shall be applied to: -

- Heating systems including pipework, calorifiers, feeds and vents, etc., but excluding any pipework or any final connections that are so located and designed as to contribute heat to the space, in addition to the heat emitter.
- Heating pipework serving LST emitters shall be insulated throughout such that no surface exposed to the users exceeds a temperature of 43°C.
- Hot and cold water service systems including calorifiers, cylinders, storage cisterns, but excluding final connections to draw-off points in "domestic" locations unless such draw-off points require frost protection. Large external cold water storage cisterns should be insulated as specified elsewhere.
- Pipework and vessels etc., in a heat recovery, DX refrigeration or chilled water system.
- Steam and condensate pipework systems including accumulators, pipework, hot wells, condensate receivers and boiler blow down pipes. Condensate cooling legs shall not be insulated.
- Safety valve discharge pipes for steam, heating and hot water where required to prevent danger to personnel.
- Boiler flues, smoke boxes, grit arrestors, and ID fans, internal and external.
- Oil storage vessels and pipework allowing for any trace heating system by others. Coal conveying pipework, external only.
- Supply air-handling plant including heater or cooler batteries and intake ductwork to plant, insulated and then vapour sealed to prevent condensation.
- Ductwork carrying heated, cooled, tempered or conditioned supply air or extracted air for re-use by recirculation, or for extracted air forming part of a heat recovery system.
- Air extract ducting to atmosphere - where such ducting passes through occupied areas and contributes to the heat gain/loss of the occupied area.
- Any pipework with heated/cold/chilled fluid, within hollow partition, "boxed-in", floor screeds and all pipework subject to potential frost conditions.

Any other requirements will be detailed elsewhere.

2.2.6 Alternative Makes

The use of other forms of insulation, or other manufacturer's products, may be considered provided they comply fully with the requirements laid down in this Specification. This applies to insulation such as flexible Class O rated types which may be used in confined spaces e.g. between partitions. They shall also be subject to the approval of the Consulting Engineer before including within the tender return, ordering or installing; at least one month's notice is required for approval.

2.2.7 Availability of Materials

Insulation thickness specified may not always be stock items. Delays to the contract due to non-availability, or poor availability, of materials etc., shall not be accepted. If necessary the MEC shall allow for utilising the nearest greater thickness insulation at no additional cost to the contract.

2.2.8 Pipework Clearances

The MEC shall leave sufficient clearance between each pipe/service to allow for the thickness of insulation specified in the tables of this section and to give good maintenance access between insulated services.

Additional space/clearance may be required where insulated pipe sleeves are used, e.g. steam, cold and chilled water services, and heated/cooled etc., ductwork.

Please also refer to the general pipework clauses for further guidance.

2.2.9 Materials – General Requirements

All insulation materials shall be: -

- Obtained, where available, from a BS EN ISO 9000 "Quality Systems" certified manufacturer.
- New and totally free of asbestos.
- All external surfaces of pipes and ducts shall be cleaned before application of insulation. Particular attention shall be taken to remove all dust, cement, plaster etc.

- Environmentally friendly. All insulation shall be CFC, HFC and HCFC free with a zero ozone depletion potential and GWP less than 5.
- Provided with a weatherproof quality finish for outdoor (external) situations.
- So protected, manufactured, constructed and installed to prevent electrolytic action, corrosion or decay.
- Chosen to ensure that they are durable and shall maintain their installed thermal conductivity (λ - value) for the expected life of the installation.
- Rot proof, non-hygroscopic, free from animal hair, VOC's or settling under vibration and resistance to attack and damage by vermin and to the growth of fungi.
- Free from objectionable odours at their temperature range band.
- Free of chemicals which may contribute to corrosion of the insulated surface or surface finish.
- Delivered to site new and fully dried out and so stored and maintained throughout the Contract. Damp or wet insulation, even if dried out, shall not be used.
- Applied to individual pipes or ducts. Adjacent parallel pipes or ducts shall not be married together with one common insulation covering unless specifically detailed on the drawings or specification e.g. trace heating/fuel oil.
- Applied after the particular service installation section has been successfully pressure tested and steel pipework painted by the MEC. All traces of surplus flux, building material dust and debris shall be completely removed from the surface of copper pipework.
- Commenced when the Consulting Engineer or his representative informs the MEC that the works above have been satisfactorily completed.
- Identified as detailed elsewhere in this specification.
- If exposed to view (internal or external) and below 2 metres from finished floor level, complete with mechanical protection.
- Should have the relevant certification undertaken in line with the required EU method, indicating that fibres are not classified under the CHIP 98 Regulations and EU Directive 97/69/EC.
- Responsibly sourced.
- Have low embodied impact relevant to their thermal properties determined by the Green Guide.

Insulation shall NOT: -

- Be bonded (nor any covering) by any adhesive/sealant or banding which may cause a fire hazard or emit dense smoke or toxic fumes, if subjected to excessive heat such as in a fire.
- Suffer deterioration at the maximum temperature under the specified conditions of use.
- Suffer permanent deterioration as a result of contact with moisture due to condensation or other sources.
- Be supported on wood, cork or polystyrene etc., blocks or segments used as insulating pads/collars.
- Be applied to condensate cooling legs.
- Shall not be classified under the CHIP 98 Regulations and EU Directive 97/69/EC.

2.2.10 Materials – Damage

Insulation and protective coverings shall be: -

- Protected during the progress of the works,
- Maintained dry as appropriate,
- Fabricated to allow for expansion, contraction, ease of access for maintenance, testing, operation or replacement of equipment without damage to the service or insulation,
- Protected against mechanical damage where run exposed on the surface in vulnerable areas, e.g. an installation at low level in a corridor, which may be subject to impact by cleaning machines, trolleys, etc.

The MEC shall take appropriate steps to prevent damage to new and/or existing pipework, ductwork and plant etc., throughout the progress of the works. This requirement shall also apply to new and/or existing insulation of services. Any damage shall be rectified at no additional cost to the Contract and to the satisfaction of the Consulting Engineer and Contract Administrator or his representative.

2.2.11 Installation Requirements

The Insulation Sub-Contractor shall: -

- Ensure that the correct thickness, thermal conductivity, fire rating and density of insulation the company installed is applied as required in this Specification and relevant ISO/British Standards.

- Insulation not complying with these requirements shall be removed and replaced with new insulation complying with the requirements, all at the Insulation Sub-Contractors own expense with no impact on the contract cost or programme completion date.
- Ensure that unless stated otherwise the insulation covering/finish shall be reinforced aluminium foil finish. The insulation and its covering/finish shall have a Class 1 rating, minimum to BS 476, and be classified Class O in accordance with the Scottish Government's Technical Handbook 2016 Non-Domestic - Fire and current amendments.
- Ensure that all insulation is firmly secured in accordance with the manufacturers' recommendations. E.g. with bands of 50mm reinforced aluminium foil adhesive tape, 25mm MS black lacquered bands, 20mm lightweight aluminium bands, insulation hanger pins and washers; at not greater than 400mm equidistant centres.
- Use only insulating materials of a reputable manufacturer, BS EN ISO 2000 approved. The thermal insulating properties shall relate to the manufacturers' declared fully aged value of conductivity (l - value) at appropriate mean temperatures of the insulation for the operating conditions of the service to be installed.
- Provided proof, prior to installation, to the Site Engineer, Clerk of Works that the insulation complies with the requirements of this specification and in particular items mentioned above.
- Apply the insulation strictly in accordance with the insulation manufacturers' recommendations and instructions; work done failing to comply shall not be accepted.
- Ensure that all work be left perfectly smooth, clean and properly finished. All unused insulation, finishes and packaging etc., shall be removed from the site before the final acceptance of the works. All fibrous particles remaining after cutting and fabrication shall be removed by suction cleaning at the end of the workday.
- At the Consulting Engineer's request, cut out one section of the insulation on each of the services to verify the thickness and/or density and reinstate the insulation at the Insulation Contractor's own expense.
- If defects are revealed, cut out two further sections of suspect insulation, for inspection.
- If further defects are revealed, the MEC shall at his own expense remove the whole of the installation and provide and fix new insulation to the satisfaction of the Consulting Engineer.
- Give particular attention to the finished appearance of all thermal insulation, which shall present a neat and symmetrical appearance, running true in line with pipe or duct layouts.
- Strip down any poor quality, irregular or badly finished or installed insulation and/or surfaces and re-instate, at his own expense, to the satisfaction of the Consulting Engineer or his representative.
- The MEC shall be responsible for the insulation installations until practical completion (Partial or Full). Any damage shall be made good at the MECs expense so that the installed insulation is handed over in perfect condition.

2.2.12 Fire Performance

All thermal insulation and protective coverings shall meet the requirements of BS 5422 when tested in accordance with the relevant parts of BS 476.

Where located in cavities, of a class required by Current Scottish Government's Technical Handbooks, Approved Document B, Appendix F.

Where located in rooms, circulation spaces and protected shafts, of a class equal to the class for walls in current Scottish Government's Technical Handbooks.

When required Class 1, be construed and tested in accordance with Scottish Government's Technical Handbooks.

Under no circumstances shall insulation be carried through fire compartment walls or floors unless it complies with the current Scottish Government's Technical Handbooks. Fire stop unit(s) shall be used wherever the services perforate a compartment wall or floor designed as a fire barrier, as required by the Scottish Government's Technical Handbooks. The requirements of BS 476 shall also be complied with. The cost of the provision of a fire stop unit shall be included and identified separately.

The above requirement shall apply to all insulated ventilation ductwork except for fire barriers where fire dampers are used.

Attention is drawn to the risk attached to the use of PVC, PIB, Foamed Rubber, Polyurethane, Polystyrene or Isocyanurates etc. Even where these materials are claimed to be fire resistance and/or self-extinguishing, they have proved in the past to be highly combustible and produce toxic smoke causing a hazard to persons working in the area and to firefighting teams. **These types of insulation or finish shall NOT be used.**

2.2.13 Earth Bonding

Where insulation with a sheet metal surface finish is used e.g. aluminium stucco sheeting etc., is shall comply with the current IEE Regulations, (BS 7671) as regards the facility to be electrically bonded to a protective conductor.

The bonding shall be carried out by the Electrical Contractor, but the facility for connections shall be included for by the MEC in his tender. Insulation of pipework, ductwork or plant, finished with aluminium sheeting, or any other metal (but not aluminium foil) shall be bonded.

2.2.14 Thermal Insulation Materials

All thermal insulation materials shall comply with the following: -

Thermal Insulation Materials				
Code	Material	Temp. Range (°C)	λ Value (W/mK at mean temp.)	Material Density (kg/m³)
CS	Calcium silicate preformed pipe, lags and slab sections	Up to 650°C	0.058 @ 100°C	Not less than 210
GF RF	Bonded pre-formed man-made glass/rock fibre mats and mattresses	Up to 300°C	0.044 @ 100°C	GF: not less than 50 RF: not less than 60
GF RF	Bonded preformed man-made glass/rock fibre pipe sections	Up to 230°C	0.043 @ 100°C 0.043 @ 100°C	GF: 80-110 RF: 100-140
GF RF	Bonded man-made mineral fibre slabs	Up to 400°C	0.047 @ 100°C 0.047 @ 100°C	48+ 60+
GF RF	Flexible mattresses Flexible mattresses	Up to 230°C	0.065 @ 100°C 0.044 @ 100°C	20 45+
PF	CFC-free phenolic resin (foam) insulation. Pipes lags, sheet and slab sections. (See Note 1)	-180°C Up to +100°C	0.018 @ 10°C 0.023 @ 50°C	Not less than 35
ENR	Elastomeric nitrile rubber (Closed-cell – Class O only)	-40°C UP to +105°C	0.036 @ -10°C 0.041 @ +20°C	Not less than 90

Notes

1) Materials extruded in lieu of machining are acceptable providing that they are satisfactory for the duty.
2) Preformed/pre-moulded bends, flanges and valve covers to the respective requirements above (thicknesses same as the pipework) may be used: the overall finish/covering to be the same as the adjacent pipework.
3) The name of the insulation manufacturer shall be given to the Consulting Engineer prior to the installation of any insulation.

2.2.15 Protection and Protective Coverings - Materials

Aluminium foil laminate shall be factory applied 'Bright Class 0' reinforced aluminium foil laminate, consisting of minimum thickness 12 micron aluminium/5 x 5mm glass scrim/22g/m² low density polyethylene. Foil thickness shall be 0.08mm minimum and arranged to achieve a Class 0 fire rating.

Where longitudinal joint overlaps are provided, the overlap shall be at least 50mm, with a factory applied seating strip. Otherwise, longitudinal and circumferential joints shall be sealed with matching self-adhesive 'Class 0' foil tape not less than 50mm wide. The foil finish shall not come into contact with any pipework surface, such that electrolytic corrosion is avoided.

2.2.16 Protection and Protective Coverings – Plantrooms and Boiler Houses

Services in Plantrooms and Boiler Houses shall be covered with aluminium sheet or steel sheet with aluminium and zinc coating (minimum thickness as below) secured with aluminium bands, 'pop' rivets or self-tapping screws at 50mm pitch. End joints shall be covered with 75mm wide aluminium strip and purpose made aluminium caps.

When a vapour barrier is required, all joints shall be sealed with a suitable coloured sealant. Overlap on longitudinal joints shall be 50mm minimum. Heat bridges between the hot surfaces and the metal casings are not acceptable. Aluminium finish is not to come into contact with any pipework surface, such that electrolytic corrosion is avoided.

On cold services, care shall be taken to avoid puncturing the insulation vapour barrier jacket with rivets or screws.

Thickness of Aluminium / Steel Protective Covering	
Insulation Outside Diameter (mm)	Insulation Outside Diameter (mm)
Up to 150mm	Up to 150mm
151mm to 450mm	151mm to 450mm
Over 450mm	Over 450mm

2.2.17 External Services (Exposed or in Non-Weathertight Ducts)

Where exposed to view, services shall be weatherproofed with Plastisol coated sheet steel (minimum 1mm) protective covering all in accordance with the relevant sections of this specification. The final colour shall blend in with building structure (colour to be agreed with client).

Where not visible, flat sheet plain aluminium sheet shall be used, all as described for plantrooms and boiler houses elsewhere in this specification.

For closed-cell elastomeric nitrile rubber insulation, where the surface of the material is exposed to water, sunlight, UV radiation or attack by aggressive chemicals, it shall be protected using a proprietary paint finish, applied strictly in accordance with the manufacturer's recommendations. A minimum of two coats shall be applied.

2.2.18 External Services (Buried Within Trenches)

Where the material is buried in trenches, the insulation shall be protected by an outer rigid pipe to prevent the insulation being crushed and losing its effective thickness. When buried where it will be in wet or moist ground for long periods, then the sealed material is to be wrapped in a Fibaroll fibre reinforced plastic or waterproof tape, e.g. Denso tape or approved equivalent, prior to being protected by an outer rigid pipe.

2.2.19 External Trenches

Pipework in external covered trenches or ducts shall be insulated with calcium silicate or phenolic foam (refer to Clause 2-3 for usage) insulation sections, with aluminium foil outer finish. The installation of the insulation shall comply with the requirements of this Specification and also BS 4508 (formerly CP 3009), as applicable.

This requirement shall only apply if ducts are FULLY AND TOTALLY weathertight. If not weathertight, i.e. slab covers, the above clauses shall apply.

2.2.20 Vapour Barriers

On refrigeration, domestic cold or chilled water, or warm/cooled air services the insulation and its covering/finish shall be continuous, maintained dry, completed and sealed as a vapour barrier throughout before reducing the service to its working temperature. Insulated pipe/duct supports shall be used on the above services to ensure continuity of the insulation and vapour barriers.

The vapour permeance of the finished installation shall not exceed 0.01 g/(s.MN) for refrigeration work, 0.015 g/(s.MN) for chilled water installations and 0.05 g/(s.MN) for cold water supplies, to BS 5422. Protection coatings, adhesives etc., shall be non-toxic and when dry be Class 0 fire rated. All terminations of and protrusions through the insulation vapour barrier shall be provided with vapour seal mastic, (including all valve stems).

2.2.21 Insulation of Supports

Supports, valves and flanges shall, generally, be insulated with the material, to the same thickness but a higher load bearing density, as that on the pipe or ductwork to which they are attached. The methods of supports shall be: -

All pipework (excluding cold feeds, vents, gas) in boiler houses, plant rooms, in ducts passing under occupied rooms, external ducts and pipes subject to external and/or frost conditions and all steam, condensate, LPHW, domestic hot, domestic cold, chilled water and refrigeration pipework shall be fitted with insulated supports whereby the insulation is continuous and not punctured.

The supports shall be of material of sufficient loading at these points and shall be to the same finish as the adjacent pipework.

Insulated pipework supports for Mineral Wool insulation will be phenolic (where permitted and up to 100°C) or calcium silicate (up to and above 100°C) type, to the higher load bearing density detailed herein, due to equivalent insulated block supports

not being available in mineral wool form. Where this is the case the insulated blocks shall be to the same thickness and finish as the adjacent mineral wool pipework.

All pipework in spaces and voids that are unheated, including cold roof voids, shall be fitted with insulated supports. The Architects drawings shall be referred to. These drawings will be available for inspection at the Architects office during the tender period. During the construction period the drawings will be available on site.

Insulated supports must be used on all domestic cold, chilled water and refrigeration pipework wherever installed. The insulant shall have a λ-value not exceeding 0.060, be wider than the pipe clip and of a corresponding thickness to that specified for the service. The whole shall be encased in a reinforced sleeve (GRP or MS galvanised) of greater length then the isolating load bearing ring of insulation. The installation shall be as outlined in BS 5970. Supports for warm heat recovery or cooled air ductwork (to the requirements above) shall be to HVCA DW 144.

Where hangers and/or supports occur along the run of insulated pipework (other than that mentioned above), the insulation shall be cut back (approximately 20mm total) to permit the protrusion of the support device and finished either side with insulated end caps (Inns ends) comprising the same insulation and finish as that of the pipework, except on service requiring a vapour seal where an insulated support will be required.

Wood, cork or polystyrene blocks etc., or segments as an insulating pad or collar are NOT acceptable.

The insulated supports for pipes and ductwork should be manufactured by one of the following: -

- Stuart Forbes (Grip Units) Limited
- For use on all services requiring insulated supports.
- Kingspan Industrial Insulation Limited - Kooltherm range.
- For use on all services up to 100°C and where approved by the Consulting Engineer only except steam and condensate (material density to be 80 kg/m³ minimum).
- Any equivalent manufacturers who complies with the above requirements and also complying with BS 5970 or HVCA DW 144.

2.2.22 Valves and Flanges

Insulated valve and flange cover boxes shall be included for on the following services: -

Service	Items to be Insulated
Chilled Water and Refrigeration	15mm pipe and above – All
Cold Water Services	Valves and all flanges and pump casings (insulated and vapour sealed)
Steam, LPHW and HWS Services	15mm pipe and above – All valves and flanges
Condensate, Fuel Oil and Coal Conveying Pipework	25mm pipe and above – All Valves and flanges
All external services and services in “cold” roof spaces	15mm pipe and above – valves and flanges

Where specified in the particular sections of this specification or where general maintenance or service access is required to valves or valve sets (typically steam trap sets, etc), full insulated flexible valve jackets shall be installed.

The valve jackets shall be fixed over valves using Velcro straps with drawstrings at either end of the jacket. The jackets shall have a robust, waterproof fabric finish fully stitched with flexible thermal insulation which meets the overall thermal performance of the insulation applied.

Materials for construction shall be fully suitable for the temperature of the service being insulated and shall typically be: -

- Inner finish: Silicone coated glass fibre
- Outer finish: Woven glass fibre
- Insulation: Mineral fibre
- Stitching: Polyester cotton
- Drawcords: Nylon

Services subject to condensation, including chilled water and cold water services, shall be fully vapour sealed beneath the jackets, with the vapour seal applied directly onto the adjacent pipework and valve (including valve items).

Each box shall comprise of an aluminium (thickness equal to that on pipework) split casing fitted with spring clip fasteners and lined with an insulation material, suitable for the particular service.

The boxes (and insulation) shall be suitable for the size and type of valve or flange and shall be neatly and properly finished.

Boxes shall be installed on all flanges and valves including control valves (but not control motors).

All joints in the casings shall be suitably sealed.

Where available preformed valve and flange insulation mouldings shall be used: flexible coverings may also be considered.

Phenolic insulation shall not be used on steam valves and flanges.

The glands on valve spindles shall project beyond the insulation.

Where required, provision shall be made in the valve and flange boxes to accommodate trace heating of the pipework.

External valve and flange boxes shall be suitably weather- proofed and sealed as for the pipework to which they are attached. Valve boxes shall include removable covers over handwheels and stems; see also BS 5970.

2.2.23 Walls and Fire Barriers

Where insulated services pass through a structure the provision must accommodate the insulation unless omitted by detail. At fire barriers the fire integrity of the barrier must be maintained by converting the insulation to a non-combustible type e.g. mineral wool, all suitably fire stopped.

At fire barriers and structures and thickness of insulation may be varied, but care must be taken to prevent heat transfer sufficient to cause deterioration of the building fabric.

All services with a vapour barrier shall be arranged such that the vapour barrier is continuous through the wall / fire barrier by use of oversized sleeve or equivalent.

The above requirements shall apply to all insulated ventilation ductwork, except for fire barriers where fire dampers detailed elsewhere will be used.

2.2.24 Sealing of Insulation

Vapour barriers insulation finish shall be effectively sealed and maintained with the materials specified. Coating shall be evenly applied; where sealing tape is used it shall be approved by the insulation manufacturer and securely fixed to the insulation with an approved (or self) adhesive coating.

Sealing tape incorrectly applied or poor fitting will not be accepted. Any puncture or damage to the vapour seal shall be carefully and effectively repaired with a suitable sealant. At entries into buildings the weatherproofed insulation shall extend not less than 100mm beyond the inner face of the wall and be correctly fire stopped and sealed.

2.2.25 Adhesives / Sealants

The adhesives/sealants shall be suitable for the insulation (and condition of use) they are required for.

The adhesives/sealants used for bonding the insulation, its finishes/coverings, or in providing a vapour barrier, shall not in itself cause a fire hazard or emit dense smoke or toxic fumes in the event of a fire or excessive heat. The application of adhesives/sealants shall comply with the requirements of the Health and Safety at Work Act.

2.2.26 Floor Ducts / Screeds

Pipework installed within floor screeds shall normally be insulated using preferred sections; however, where space does not permit them to be used it shall be insulated by packing plain finished glass or rock fibre mattress insulation beneath, between and above the services, thereby filling the duct with insulation.

2.2.27 Plant Access

Aluminium sheet covering or steel sheet with aluminium and zinc coating shall be securely fixed to the insulation in an approved manner and shall be neatly jointed and shaped to suit the plant/equipment contours. Where removable access or sections are incorporated on the plant, the insulation and covering shall be arranged so that it can be removed from the

relevant area without disturbing the remainder of the insulated surface. Removable sections of insulation and coverings shall be fitted with approved quick release type fasteners.

Reference should be made to the requirements/recommendations of BS 5970.

2.2.28 Slab Insulation Supports

The supports for slab insulation, excluding boiler flue supports, shall be pre- manufactured

2.2.29 Expansion Bellows

Expansion bellows shall be insulated with preformed rigid sections of the same thickness, density and thermal conductivity as on the adjacent pipework.

The sections shall be applied over the flanges of the bellows and clear of convolutions and bolts.

The sections shall be finished (and where installed externally be weather proofed) as for the adjacent pipe and be constructed as for valve boxes. Please also refer to BS 5970.

Note: Insulation shall not be applied until any "cold draw" has been taken up.

2.2.30 Identification

All insulated pipework and ductwork services shall be identified with colour bands to BS 1710, unless the colour code at an existing facility is different, in which case the Consulting Engineer shall be consulted.

Identification bands shall be a minimum of 100mm wide and shall be applied on the insulation to each service at 6m internals and at all branches and on both sides of any floors and walls through which the service(s) pass.

All services shall be further identified with the name of the pipe/duct contents on the insulation, adjacent to all valves or dampers, at all changes in direction, at all inlets and exits to ducts and departments and at either side of walls, or floors. The size of lettering shall be approximately 25mm high.

Arrows indicating the direction of flow of the pipe/duct contents shall also be applied adjacent to the name of the contents. The arrows shall be 75mm long. On heating, hot, chilled water and refrigeration services etc., add 'F' to demote flow and 'R' to denote return.

The lettering and arrows shall be black or white to contrast with the colour of the insulation.

Warning labels shall be fixed to the insulation on electric trace heated pipelines stating the voltage.

After installation (and insulation where called for) ductwork shall be identified, by colour coding, in accordance with HVCA DW 144 - "Specification for Sheet Metal Ductwork".

Uninsulated pipework etc. shall be left unpainted except for steel pipes which shall be primed or painted, see Standard Technical Clauses for requirements. In exposed areas, offices etc., pipework/ductwork will be painted in normal decorative colours, identification shall be provided at appropriate points, within the building/department, where the services enter and leave.

Note: Aluminium based paints are not to be used in the vicinity of flammable liquids or flammable gases, not in the vicinity of pipes carrying flammable liquids or gases, due to the possible risk of an explosion.

2.2.31 Combinations of Insulation and Coverings for Plant and Equipment

The selection of insulation materials shall be from the following tables and to the requirements and thicknesses given in subsequent tables. The requirements and thicknesses are minimum standards.

With these tables, the following definitions apply to locations: -

Plant	**Includes boiler rooms**
Trench	A covered horizontal service space in the floor or ground within access panels.
Cavity/ceiling space/roof space	A space enclosed within the elements of a building within which services are installed, as a cavity. See Scottish Government's Technical Handbooks.
Occupied	All occupied areas, exposed to view.
Outdoor	Outdoor, exposed or in an open or non-weathertight trench
Duct	An enclosed space specifically intended for the distribution of services, with direct access for personnel. These are generally of the walkway or crawl-way type.
Plant	Includes boiler rooms

2.2.32 Thickness of Insulation

Thickness Tables 1 to 7 shows the thicknesses required to comply with BS 5422, and is based on the following typical thermal conductivity values declared by manufactures at the appropriate mean temperature of insulation for the specified operating conditions. Manufacturers' nearest standard thicknesses are shown in the tables.

Insulating Material	Mean Temperature of Insulation (°C)				
	0	20	50	75	100
	Thermal Conductivity (W/mK)				
Phenolic foam	0.018	0.02	0.023	0.025	x
Mineral wool	x	0.034	0.037	0.04	0.044
Nitrile rubber	0.038	0.04	0.044	0.048	x
Calcium silicate	x	x	0.05	0.052	0.054

The Environmental Thickness Tables in BS 5422 are specified by the DETLR as the basis of qualification for Enhanced Capital Allowances and as a means of compliance with the Scottish Government's Technical Handbooks.

For NHS funded projects the thickness of insulation shall be in accordance with the NHS CO2 Thermal Insulation Specification.

- The tables on the following pages are derived from current TIMSA guidance (referred to in the Scottish Government's Technical Handbooks and British standards. When using the tables the MEC shall Include for: -
- Thickness of insulation are calculated against the criteria stated in the particular table, where actual conditions differ the nearest more onerous condition shall be used.
- The thicknesses shown are the minimum required and do not take account of manufacturers standard thicknesses, the MEC shall select the nearest equal or larger sized insulation from the manufacturers range.
- These tables establish the minimum requirement. Please refer to specific sections of this specification for particular requirements which shall be adopted if more onerous.
- Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing under extreme conditions. In these cases, to provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled circulation of the water or trace heating.
- Thickness calculations ignore the specific heat capacity and surface resistance of the insulation.

Table of Combinations of Insulation Materials and Coverings				
Service	Service	Service	Service	Service
Valves and Flanges	Any Area	RF / GF / CS / PF	As for pipework	
Expansion Bellows	e.g. Residential	RF / GF / CS / PF	As for pipework	
Ducting Flanges	Any Area	RF / GF / CS / PF	As for pipework	
HWS @ +60°C Cylinders	Any Area	RF / GF / CS / PF	Table 6	Aluminium Sheet
HWS @ +60oC Cylinders	e.g. Residential	Domestic Sectional To BS 5615	Table 6	Pre-insulated
Cold Water Storage Cisterns	Outdoor -to be detailed elsewhere	RF / GF / CS / PF	Table 4	Aluminium Sheet
Chilled Water Tanks @ +5°C	Any Area	RF / GF / CS / PF	Table 4	Aluminium Sheet and Vapour Barrier
F & E Cisterns	Any Area	RF / GF / PF	Table 4	Aluminium Sheet And Vapour Barrier
Heating @ +150°C Calorifiers	Any Area	RF / GF / CS	Table 3	Aluminium Sheet
Hot Wells	Plant	RF / GF / CS	Table 3	Aluminium Sheet
Condensate Receivers	Any Area	RF / GF / CS	Table 3	Aluminium Sheet
Boiler Smoke Boxes, Flue Ducting	Plant	CS	100	Aluminium Sheet
Grit Arrestors, ID fans	Plant	RF / GF	100 plus 25mm air gap	Aluminium Sheet

Notes

1) CS - Calcium silicate
2) MC - Magnesium Carbonate
3) GF - Glass Fibre
4) RF - Rock Fibre
5) PF - Phenolic Foam, refer to restrictions in use detailed in this specification.

Table 3 – Environmental Thickness of Insulation for Non-Domestic Heating Installations to Control Heat Loss							
Steel Pipe Size (mm)		Hot face temperature of insulation (°C)					
		+75°C		+100°C		+150°C	
		Thickness of insulation (mm)					
NB	OD	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Mineral wool	Calcium silicate
15	21	15	35	15	42	50	80
20	27	16	40	20	53	60	80
25	34	20	40	21	62	60	100
32	42	20	42	24	66	74	117
40	48	21	44	25	67	77	120
50	60	23	46	27	71	83	125
65	76	25	48	30	74	88	129
80	89	25	50	31	76	91	132
100	114	27	51	34	79	96	136
150	168	29	53	38	83	103	141
200	219	30	54	40	85	106	144
250	273	31	54	42	87	109	145
300	324	31	54	42	87	109	145
Vessels and flat surfaces		35	60	50	100	120	150

Table 4 – Thickness of Insulation for Chilled and Cold Water Supplies to prevent Condensation and Control Heat Gain on a Low Emissivity Finish with Ambient Conditions of 25°C, 80%. (Also applies to condense pipework)							
Steel Pipe Size (mm)		Hot face temperature of insulation (°C)					
		+10°C		+5°C		0°C	
		Thickness of insulation (mm)					
NB	OD	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
15	21	15	20	15	28	20	34
20	27	15	25	15	30	20	40
25	34	15	25	20	31	25	40
32	42	15	25	20	32	25	50
40	48	15	30	20	33	25	50
50	60	15	30	20	40	25	50
65	76	20	30	25	40	30	50
80	89	20	30	25	40	30	50
100	114	20	30	25	40	30	50
150	168	20	40	30	50	35	60
200	219	20	40	30	50	40	60
250	273	25	40	30	50	40	65
300	324	25	40	35	60	40	65
Vessels and flat surfaces		30	50	40	65	50	80

Table 7 – Minimum Thickness of Insulation Required to Give Protection Against Freezing Under Specified Commercial and Institutional Conditions					
Initial water temperature (°C)		+2°C		+2°C	
Minimum ambient temperature (°C)		-6°C (Indoor unheated area)		-10°C (Outdoor)	
Evaluation Period		12 hours		12 hours	
Permitted ice formation		50%		50%	
Pipe Size (mm)		Thickness of insulation (mm)			
OD	Bore	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
Copper Pipes					
15	13.6	23	78	68	413
22	20.2	10	23	21	58
28	26.2	7	13	13	28
35	32.6	5	10	9	18
42	39.6	4	7	7	13
54	51.6	3	5	5	9
76.1	73.1	2	4	4	6
108	105.0	2	3	3	4
Steel Pipes					
21.3	16.0	18	48	44	173
26.9	21.6	10	21	20	52
33.7	27.2	7	14	13	29
42.4	35.9	5	9	9	17
48.3	41.8	4	7	7	13
60.3	53.0	3	6	5	10
76.1	68.8	3	4	4	7
88.9	80.8	2	4	3	6

Table 8 - Combinations of Insulation and Coverings												
Piped Services	Locations	Thermal Insulation 01 – Magnesia Sections 02 – Calcium Silicate 03 – Mineral Fibre Mats 04 – Mineral Fibre Sections 05 – Mineral Fibre Slabs 06 – Phenolic Foam (see note 1)						Covering A – A1 Foil (Class 0) B – A1 Sheet C – Plasisol Alu. Sheet D – PVC Sheet			
		01	02	03	04	05	06	A	B	C	D
MTHW Heating LTHW Heating DHWS (less than 100°C)	Plant Rooms		✓		✓		✓		✓		
	Ducts		✓		✓		✓	✓	✓		
	Cavities		✓		✓		✓	✓			
	Occupied (exposed to view)		✓		✓		✓	✓	✓		
	Outdoor		✓		✓		✓		✓	✓	✓
Cold Water Service Chilled Water Service (see note 2)	Plant Rooms		✓		✓			✓	✓		
	Ducts		✓		✓			✓	✓		
	Cavities		✓		✓			✓			
	Occupied (exposed to view)		✓		✓			✓	✓		
	Outdoor		✓		✓			✓	✓	✓	✓

Notes

1) For phenolic foam, refer to restrictions on use detailed in this specification.
2) Where pipework is exposed to view, refer to further requirements detailed in this specification, in addition to the tabled requirements.

2.3 HVAC AUTOMATIC CONTROLS

2.3.1 Introduction

The MEC shall supply, install and commission the HVAC Automatic Controls installations as detailed on the tender drawings and within this specification, employing specialist sub-contractors and manufacturers / installers as necessary.

The works shall be to the requirements of the Contract documents and to the satisfaction of the client.

The MEC shall state, at the time of tendering in the Specification Tender Analysis, the name of the HVAC Automatic Controls Sub-Contractor who will carry out the work. Alterations/changes of HVAC Automatic Controls Sub-Contractors, from those listed in the Tender Return, shall not be accepted without prior agreement by the Consulting Engineer and documented evidence giving reasons for change.

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

2.3.2 Standards

Building Energy Management Systems (BEMS) shall only be installed by specialist BEMS contractors who are suitably qualified, experienced and resourced. The specialist contractor shall also hold current trade approvals from the equipment suppliers.

2.3.3 Programme

The Consulting Engineer requires timely opportunity to comment on proposals at all stages of design and development of projects.

No alterations or deviation to the final tender BEMS design, strategy or documentation shall be made without approval of the Consulting Engineer. Written confirmation for any changes shall be issued by the Consulting Engineer before alterations or deviations are undertaken.

Within ten working days of receipt of an official order the specialist controls contractors shall submit a comprehensive and detailed program of works, together with a components list of all equipment including wiring diagrams (control panel internal and external layouts), plant schematics and layout drawings detailing control equipment locations. Copies shall be sent to the Consulting Engineer as applicable.

Familiarisation: Prior to commissioning, the specialist controls contractor shall meet with the Consulting Engineer to discuss and agree front end graphics, alarm priorities and notifications. This shall also include points to be logged and reports to be generated.

Demonstration: At least ten working days prior to official project handover, the specialist controls contractor shall meet with the Consulting Engineer to give a working demonstration of all complete front end graphics. This shall include all logged points, report generation alarm priorities and notifications. A site visit shall also be made where all relevant BEMS equipment shall be bought to the attention of the individuals on the visit. From this meeting a snagging list shall be generated by the Consulting Engineer and an agreed date set for completion.

Official hand over: On the agreed date for official handover, the specialist controls contractor shall issue a complete set of O&M documentation to the Consulting Engineer. On the same date, completed graphics and labelling shall be available to view and use on the BEMS front end, all alarm priorities and logging shall be set and in full operation. Specific maintenance instructions for controls and associated outstations shall be specified to the Consulting Engineer.

Within ten working days of project handover, the specialist controls contractor shall provide the Consulting Engineer with a back-up copy of the front end graphics and outstation programming data files which shall allow access for modifications to be added in the future by the supplying system house or others.

2.3.4 Responsibilities

It is the intention that this specification provides an indication of the requirements expected by the Consulting Engineer. For any area not covered in this specification, or where clarification is required, it is the responsibility of the MEC and/or specialist BEMS contractor to liaise with the Consulting Engineer to ensure that the Client's requirements are being fulfilled.

The MEC and specialist BEMS contractor shall give written assurance that the proposed system has a minimum 10 year supported life cycle, is open protocol and the system is compatible with current systems installed.

Specialist BEMS contractors shall ensure that all control wiring installations are carried out in strict accordance with current IEE Wiring Regulations (BS7671).

Specialist BEMS contractors shall ensure all field equipment can relay feedback to the BEMS front end, including actual valve/damper position indication. Modulating valves shall provide 0-10V feedback signals and switched isolation valves shall provide either 0-10V feedback or end of travel signalling.

2.3.5 Energy Efficiency

Consideration shall at all stages be given to energy conservation and ensuring any BEMS system installed shall provide a comfortable environment for building end users. All installations shall allow for safe planned preventative maintenance and service of plant and associated equipment.

2.3.6 Control Panels – External Requirements

Where required and where space permits, each panel shall be divided in two sections, one for power and one for control, with a door interlocked isolator on the power section on the panel. The door interlocked isolator shall be provided with an engineer's bypass facility to allow access during maintenance without unnecessary interruptions to the plant operation. Door isolators shall be self-supporting and shall fully engage when shutting the panel door.

All panels shall be fitted with LCD touch-screen displays.

All panels shall have ON/OFF/AUTO 3-way switches for all main plant items.

All lamps shall be LED type and shall indicate with the following colours: -

- Green: Run / Enabled.
- Red: Trip / Fault.
- White: 24V control circuit live indication on panel.

The panel shall incorporate a lamp test facility.

All electrical power circuits emanating from control panels shall be protected by a suitably rated MCB to protect the cabling and the mechanical plant it serves.

All cable entry points into panels shall be via suitably-sized glands, or trunking with sealed connections, to ensure the IP rating of the panel is not compromised.

2.3.7 Control Panels – Internal Requirements

All electrical wiring shall be contained in plastic slotted trunking with appropriate capping fitted. This shall be of a size that allows for 25% increase of wiring allowing for future expansion.

Modules shall be labelled appropriately and correspond to the panel drawings.

All panels shall be supplied with 10% panel backspace and 10% incoming termination points to allow for future expansion.

Mains and 3 phase conductors shall be separated from low voltage conductors.

Permanent live connections shall be avoided. If a permanent supply is required inside a panel this shall be discussed with the Consulting Engineer and written confirmation given of its approval. This shall include appropriate labelling which shall be attached inside and outside the panel. The labels shall be of the engraved type.

For safety reasons the control circuits (both internally and externally) shall be 24V extra low voltage (ELV) with suitable MCB protection, including all outgoing control circuits, to prevent a minor problem causing complete breakdown. Mains 230V controls circuits shall be avoided whenever possible.

Safety interlocks shall be provided in accordance with the current edition of CIBSE Guide H and shall be hard-wired within each panel as required.

All relays shall have a clear visual indication of when energised and shall have a manual override facility.

A 230V double socket shall be provided within the panel.

A twin data point socket shall be provided within the panel which shall be allowed for during the panel design.

All panels shall be fitted with document holders of a suitable size to accommodate panel drawings and the associated description of operation document.

Upgraded panels shall have all redundant equipment removed this shall be offered to the Energy Team for spares.

Panels shall be clean and free from metal cuttings and off-cuts.

2.3.8 Sub-Control Panels

Sub panels shall follow the same general criteria and requirements as the main control panels.

Sub panels shall have the main panel location indicated on the panel fascia and indication that the panel is a sub panel.

2.3.9 Field Wiring

All wiring installations shall be carried out in strict accordance with current IEE Wiring Regulations (BS7671) and all other current regulations.

All works shall be carried out to a professional standard and in a manner that meets with the Consulting Engineer's approval. Should the specialist controls contractor be unsure in any way of how to achieve the best quality of installation then the advice of the Consulting Engineer shall be sought prior to works being carried out.

All wiring shall be numbered and clearly identifiable by suitable means at both the control panel and the equipment termination points to assist commissioning and future maintenance work.

All field wiring shall be contained in suitably-sized galvanised mild steel cable tray, twin compartment trunking or conduit. PVC conduits shall only be used at the discretion of the Consulting Engineer.

Screened cable shall be used for remote sensors; a minimum of 3 pairs shall be supplied to each sensor.

Suitably rated lockable rotary isolates shall be installed to provide local safe means of electric isolation.

2.3.10 Programming of BMS Controls

The specialist controls contractor shall be responsible for programming of all equipment supplied and/or installed as part of their contract, to ensure the system meets the design requirements of the project and the approval of the Consulting Engineer.

All programming shall be in accordance with the manufacturer's recommendations, shall utilise the latest software routines and shall be in accordance with the current edition of CIBSE Guide H.

2.3.11 Metering / Trend Logs

The control system shall provide the capacity for pulsed input and Modbus meter monitoring with trend logs sampling every 15 minutes.

The 15 minute trend logs shall be stored within the controller for a minimum period of seven days, with continual synchronisation to the BEMS front end server to provide both live data and data storage.

2.3.12 Field Equipment

All field equipment shall be installed in strict accordance with the manufacturer's instructions and consideration shall be given to ensure that planned preventative maintenance can be carried out safely.

All field equipment shall be labelled. All safety interlocks shall be hard wired.

All major pumps and fans (including fans located in air handling units) shall be monitored by differential pressure switches of a suitable type and calibration range that allows for wear and slight drop of performance over time. Indicator lamps shall be installed on the panel fascia to show flow condition; this shall also be visible on the BEMS front end graphics.

All gas solenoid valves shall be provided with an auxiliary BEMS connection to allow monitoring of the current state of the valve. Indicator lamps shall be installed on the associated control panel fascia to show the gas valve condition; this shall also be visible on the BEMS front end graphics and set as an alarm.

2.3.13 Sensors

The exact position of all controls sensors shall be agreed with the Consulting Engineer prior to installation.

All sensors shall be accessible and allow for maintenance and inspection requirements without the removal of pipework or thermal insulation.

Sensors shall be of a type suitable for the environment they are located, and their position shall give a true reflection of the condition being sensed.

All sensors shall be labelled to indicate their purpose.

All room temperature sensor and CO_2 sensor locations shall be indicated on the front end graphics.

2.3.14 Controller Spare Capacity

Building Controllers and Advanced Application Controllers shall be selected to provide a minimum of 15% spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15% of each type is required. If outputs are not universal, 15% of each type shall be provided.

A minimum of one spare point is required for each type of point/object used.

No additional controller boards or point/object modules shall be required to implement use of these spare points.

2.3.15 Frost Strategy

Three-stage frost protection shall be provided as detailed below and shall remain operational at all times: -

- **Stage 1** - If the outside air falls below the outside frost set point during unoccupied hours then the duty pumps shall start and the motorised valves shall open.
- **Stage 2** - During stage 1 above, the minimum boiler return temperature shall be maintained above the boiler return frost set point of 25°C.
- **Stage 3** - At all times the internal space temperature shall be maintained, with the heating being enabled at 10°C and disabled at 12°C. All set points shall be adjustable between limits via the password protected keypad display unit or remotely via the central supervisor.

2.3.16 Commissioning

The specialist controls contractor shall carry out all necessary testing and commissioning works in order to provide the Client with a fully working installation. Commissioning shall include the seasonal commissioning of all works.

All commissioning shall be carried out in such a manner as to minimise operating costs for the end user whilst fully complying with the design intent of the systems.

An adequate period of time shall be allowed to carry out the testing and commissioning works, after completion of the building works and works of other trades.

All testing and commissioning shall be witnessed and approved by the Consulting Engineer.

All commissioning shall be carried out in accordance with the CIBSE Commissioning Codes and BSRIA commissioning requirements. Where there is a difference or contradiction between these documents, the MEC shall be deemed to have included for the more onerous and rigorous, as defined by the Consulting Engineer.

Any water, fuel and energy required for testing and commissioning of the installations shall be provided by the Main Contractor and/or Client.

The specialist controls contractor shall furnish all labour and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under the specification.

The specialist controls contractor shall carry out the following commissioning procedures as a minimum: -

- Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
- Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures as per the manufacturers' recommendations.

- Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
- Verify that all analogy output devices (I/Ps, actuators, etc.) are functional, that start and travel are correct, and that direction and normal positions are correct. The specialist controls contractor shall check all control valves and automatic dampers to ensure proper action and closure. The specialist controls contractor shall make any necessary adjustments to valve stem and damper blade travel.
- Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
- Check each alarm separately by including an appropriate signal at a value that shall trip the alarm.
- Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- Provide documentation on the commissioning activities.

2.3.17 Training

The specialist controls contractor shall carry out the following training procedures: -

- Provide a minimum of one on-site training class; eight hours in length for all new equipment for personnel designated by the Consulting Engineer.
- Provide two additional training sessions at both six and twelve months following project handover. Each session shall be eight hours in length and shall be coordinated with the Consulting Engineer.

The training course(s) shall be designed and presented to enable the day-to-day operators of the controls system(s) to carry out the following duties: -

- Proficiently operate the system.
- Understand control system Architecture and configuration.
- Understand DDC system components
- Understand system operation, including DDC system control and optimizing routines.
- Operate the workstation and peripherals.
- Log on and off the system.
- Access graphics, point/object reports, and logs.
- Adjust and change system set points, time schedules, and holiday schedules.
- Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
- Understand system drawings, and Operation and Maintenance manual.
- Understand the job layout and location of control components.
- Access data from DDC controllers and ASC.
- Operate portable operator's terminals.

2.3.18 O&M Documentation

Upon completion of installation, the specialist controls contractor shall submit three copies of a comprehensive O&M document. The manuals shall cover the full scope of the services installed by the specialist controls contractor and appointed Sub-Contractor(s), including any additional works installed during the contract period.

A single copy of the document shall be submitted to the Consulting Engineer for approval no less than ten days before project handover.

A CD or DVD shall be provided with each manual, containing all information. The disk shall contain a copy of the documentation in both native format (i.e. MS Word, Excel etc.) and in .pdf (Adobe Acrobat) format, including all description of operation text, as-fitted drawings and manufacturers' literature.

The O&M document shall contain the following as a minimum: -

- Project Record Drawings. These shall be as-built versions of the submittal installation drawings. One electronic set including AutoCAD drawing files also shall be provided.
- Testing and Commissioning Reports and Checklists. Completed versions of all completed commissioning reports and checklists.
- As-built versions of the submittal product data.

- Names, addresses, and telephone numbers of Contractors installing equipment, and the control systems and service representatives of each.
- Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point/object reports, trending data, overriding computer control, and changing set points and other variables.
- Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points/objects, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
- A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.
- A list of recommended spare parts with part numbers and suppliers.
- Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
- Complete original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
- Licenses, guarantee, and warranty documents for all equipment and systems.
- Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions

2.3.19 Warranty

The Controls Specialist shall warrant all work as detailed below: -

Labour and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. The MEC shall respond to the End User's request for warranty service within 24 hours during normal business hours.

All work shall have a single warranty date, even when the End User has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period

Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the MEC shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty technical support agreement from the MEC. Written authorisation by the End User shall, however, be granted prior to the installation of any of the above-mentioned items.

Exception: The MEC shall not be required to warrant re-used devices, except for those that have been re-built and/or repaired. The MEC shall warrant all installation labour and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of the Consulting Engineer’s acceptance.

2.3.20 Ownership of Proprietary Material

All project-developed software and documentation shall become the property of the Client. These shall include, but are not limited to, the following: -

- Project graphic images
- Record drawings
- Project database
- Project-specific application programming code
- All documentation

2.3.21 Schedule of Field Equipment

The field equipment specified below shall be used throughout: -

Item	Description	Comments
Panel Document holders	-	Provided with panels
Occupancy sensors microwave	-	To suit application & location
Inverters	ABB ACH550 HVAC range	Drive Control
Siemens display screen	PXM10	Contact energy team
Delta Controls display screen	eTCH - DHMI	Contact energy team
Temperature Sensors	Siemens range	Compatible with Desigo BMS
Temperature Sensors	Delta range	Compatible with Delta BMS
Control Valves	Siemens range	Sized to application & location
Control Valves	Belimo range	Sized to application & location
Damper Actuators	Belimo or Siemens range	To suit application & location

2.3.22 BEMS Reporting Accuracy

The accuracies scheduled below for the various measured variables shall be provided by the BEMS system(s): -

Measured Variable	Reported Accuracy
Space Temperature	± 0.5°C
Ducted Air	± 0.5°C
Outside Air	± 1.0°C
Dewpoint	± 1.5°C
Water Temperature	± 0.5°C
Delta-T	± 0.15°C
Relative Humidity	± 5% RH
Water Flow	± 5% of full scale
Airflow (terminal)	± 10% of full scale *(see Note 1)*
Airflow (measuring stations)	± 5% of full scale
Air Pressure (ducts)	± 25 Pa
Air Pressure (space)	± 3 Pa
Water Pressure	± 2% of full scale *(see Note 2)*
Electrical (A, V, W, Power factor)	5 % of reading *(see Note 3)*
Carbon Monoxide (CO)	± 5% of reading
Carbon Dioxide (CO_2)	± 50 ppm

Notes

1) 10%-100% of scale
2) For both absolute and differential pressure
3) Not including utility-supplied meters

2.3.23 BEMS Control Stability and Accuracy

The system stabilities and accuracies scheduled below for the various measured variables shall be provided by the BEMS system(s): -

Controlled Variable	**Control Accuracy**	**Range of Medium**
Air Pressure	± 50 Pa	0-1.5 kPa
Air Pressure	± 3 Pa	-25 to 25 Pa
Airflow	± 10% of full scale	
Temperature	± 0.5°C	
Humidity	± 5% RH	
Fluid Pressure	± 10 kPa	0-1 kPa

2.4 ELECTRICAL SERVICES

2.4.1 Introduction

The MEC shall supply, install and commission the electrical services installations as detailed on the tender drawings and within this specification, employing specialist sub-contractors and manufacturers / installers as necessary.

The works shall be to the requirements of the Contract documents and to the satisfaction of the Architect/Contract Administrator or his representatives (including the Consulting Engineer and Clerk of Works).

The MEC shall state, at the time of tendering in the Specification Tender Analysis, the name of the Electrical Services Sub-Contractor who will carry out the work. Alterations/changes of Electrical Services Sub-Contractors, from those listed in the Tender Return, shall not be accepted without prior agreement by the Consulting Engineer and documented evidence giving reasons for change.

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

2.4.2 Standards

All electrical services works shall be carried out in accordance with the current editions of all applicable Scottish Government's Technical Handbooks, BS/EN and NICEIC/IEE standards, the most notable of which are listed below. These shall be a guide to the MINIMUM standard required and shall be overridden by the standards referred to in the rest of this specification and associated drawings.

- CIBSE Guides and Publications
- IEE Guidance Notes
- IEE On-Site Guide
- 17th Edition IEE Wiring Regulations (BS7671:2008)
- BS 5839 Fire alarm installations
- BS 5266, EN1838 Emergency Lighting installations
- All relevant British Standards.
- NICEIC Guides and Notes
- NICEIC Standard codes of Practice
- Electricity at Work Regulations
- Equality Act
- BS 8300
- Current Scottish Government's Technical Handbooks

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

2.4.3 Scope of Works

The MEC shall be totally responsible for the electrical power and control system serving the mechanical services plant. This shall include all cabling, conduits, trunking/trays, connections, final tests and commissioning.

Power supplies to the following equipment (where fitted) shall be provided by the EEC, unless stated otherwise: -

- HVAC Automatic Controls panels
- Main refrigeration plant (chillers etc.)
- AC system outdoor units, indoor units and refrigerant control devices
- Smoke damper control panels – field wiring by Controls Specialist
- Trace heating systems
- Local fans
- Local electric heaters
- Urinal flushing systems

The EEC involved with the electrical installation to the rest of the building shall provide power supplies to each HVAC Automatic control panel. From each panel, the MEC shall be responsible for all of the controls and equipment power installation, including all wiring, cable trays or other required cable containment systems.

The Mechanical Contract includes the following works: -

- The design, supply and installation of new control panels, to be located in plantrooms, and used for the complete supply and control of all mechanical services plant.
- The complete design, supply and installation of all associated cabling from the mechanical services plant control panel to all the items of equipment and associated sensors, valves, fans etc.
- Supply of all control equipment and associated wiring, including switchgear and local isolating switches.

- Erection/installation/fixing of the above.
- Wiring to all equipment from the main control panels.
- Connection of all equipment.
- Setting to work/commissioning.

2.4.4 System of Wiring

The system of wiring to be employed shall be as follows: -

Control wiring and supplies under 20 Amps: -

- In Plantrooms - LSF/Cu cables enclosed in galvanised steel conduit and trunking.
- In ceiling voids - LSF/Cu cables enclosed in high impact LSF conduit and trunking, or LSF/SWA/XLPE/Cu cables secured to galvanised cable tray.
- Externally - PVC/SWA/XPLE/Cu cables secured to galvanised cable tray.

Supplies above 20 Amps: -

- LSF/SWA/XLPE/Cu cables secured to galvanised cable tray.

The MEC shall allow to co-ordinate the routes of all trays and trunking with all other services.

Where multi-core or data control wiring is employed, this shall be enclosed in conduit or trunking.

The MEC shall provide lockable isolators and emergency stop buttons adjacent to all motor drives and make final connection in flexible, watertight conduit.

All cables used shall be BASEC (British Approvals Service for Electric Cables) Approved.

2.4.5 Protection Against Electric Shock

The 17th Edition of the I.E.E. Wiring Regulations allows alternative methods of protection against electric shock. For the purpose of this specification, protection against direct contact with live parts shall generally be by the use of the following measures: -

- Protection by insulation of live parts.
- Protection by enclosures.

The basic protection measure for protection against indirect contact shall be by earth equipotential bonding and automatic disconnection of the supply. All necessary earth bonding as detailed in the Wiring Regulations (Section 413) shall be carried out.

Protection devices providing automatic disconnection shall generally be fuses to BS 88, Part II, and/or miniature circuit breakers to BS EN 60898. The characteristics of these devices, the earthing arrangement and the circuit impedances shall be co-ordinated to provide protection against indirect contact with live parts. Where residual current devices are specified, they shall be to BS EN 61008 or 61009.

2.4.6 Protection Against Thermal Effects

The MEC's attention is drawn to Chapter 42 of the Wiring Regulations, which outlines measures to be taken in respect of protection against thermal effects.

2.4.7 Protection Against Overcurrent

With the exception of electric motors and associated circuits, circuit protection against overload and short current shall be provided by a single device.

The overload and short circuit characteristics of each device, together with circuit impedance satisfy the Wiring Regulations in respect of overload and short circuit protection, discrimination and circuit disconnection times in the event of earth fault conditions. The MEC shall ensure that no alterations, however caused, will negate this co-ordination procedure.

2.4.8 Earthing

At switch panels and other metallic electrical enclosures, reliance shall not be placed on the enclosure to form part of the protective conductor. Earthing tags or clamps and continuity conductors in conjunction with a suitable earthing bar shall be employed.

For the purpose of this Specification, conduit and/or trunking systems shall not be relied upon to form the protective conductor. Earth continuity or protective conductors shall be installed for each final circuit, which shall comply with Regulation 543.

The resistance between any point of the conduit/trunking installation and the local distribution board shall not exceed 0.1 Ohm. Conduits and distribution gear shall be earthed by means of earth continuity sockets.

2.4.9 Segregation of Services

Services shall be segregated as follows: -

- Circuits operating at low voltage and connected to the mains supply (Category 1).
- Circuits for radio, impulse clocks, alarm and call systems (Category 2).
- Fire alarm circuits (Category 3).
- Emergency lighting where central battery systems are employed (Category 3) - Must not be in the same wiring system as the fire alarm circuits detailed above.
- Telephone circuits.
- Computer data wiring where defined in other sections of this document.

2.4.10 Sizing of Final Circuits

The final circuit cable sizes designed by the Sub-Contractor shall be calculated in accordance with the 17th Edition of the I.E.E. Wiring Regulations, to satisfy the requirements of rating, voltage drop and earth impedance.

For projects involving connection to existing electrical distribution systems, and unless stated otherwise, it shall be assumed that 1.5% of the nominal voltage has been dropped on the sub-mains systems feeding the motor control centre(s), leaving a further 2.5%.

The MEC shall advise the Consulting Engineer if any proposed alteration shall result in any maximum circuit length being exceeded, together with any consequential changes that may become necessary (i.e. conduit size).

2.4.11 Wiring of Plant and Equipment

Equipment shall be wired in accordance with manufacturer's approved connection diagrams. The MEC shall ensure that the drawings have been approved before associated wiring commences.

Where cable connections are made into equipment, a numbered marker sleeve shall be fitted to each cable core, which shall correspond to the manufacturers wiring diagram.

The MEC shall ensure that all wiring connections are correctly made before any equipment is set to work.

For three phase equipment all cable insulation shall be in phase colours, (red, yellow and blue).

Phase rotation shall be corrected at the motor drive only.

Cable tails to terminals shall be of sufficient length and shall be neatly dressed and arranged to prevent development of tension in the cable or on the terminations.

Each piece of equipment remote from the main control panel(s) shall each be provided with a local isolating switch.

2.4.12 Conduit and Accessories - Metal

Metal conduit shall be used throughout, unless stated otherwise.

Steel conduit and accessories shall be heavy gauge welded to BS 4568. The finish shall be galvanised Class 4.

Conduits shall be threaded to butt closely together in couplings and sockets. Except at running couplings, threads shall not be exposed and these shall be cleaned, primed and painted immediately after installation.

Where the conduit finish is damaged during installation, the conduit shall be cleaned and painted with zinc-rich paint.

All conduit drops in chases in plastered walls to be painted with red oxide paint before plaster is applied.

All accessories used shall be of the cast iron type, i.e. no pressed steel accessories will be accepted.

All conduit drops in chases shall have a coupler inserted in the run 300mm from ceiling level.

2.4.13 Conduit and Accessories - PVC

PVC conduit shall be only used where agreed in writing with the Client and/or Consulting Engineer.

2.4.14 Conduit and Accessories - General

Concealed conduit shall be arranged on a 'loop-in' system so that all draw in points for cables are accessible at finished surfaces. No elbows or tees shall be used.

Connections to accessory boxes on a concealed installation shall be with brass bush, metal coupling and serrated washer. For surfaces installation, flanged couplers lead washers shall be used.

Conduits on exposed surfaces shall be fixed at intervals not exceeding 1200mm, also within 300mm of floors, ceilings and boxes at each side of every bend. Fixing of conduits shall be as follows: -

Type of Installation	**Method of Fixing**
Wall chases	Crampers or ordinary saddles
Ceiling, roof or floor voids	Spacer bar saddles
Surface-mounted on ceiling	Spacer bar saddles
Surface-mounted on walls	Distance saddles

The number of single core 600/1000 Volt grade cable drawn in at each conduit shall be as set out in the 17th Edition of the I.E.E. Regulations. The minimum conduit size shall be 20mm diameter.

The conduit system shall be complete and tested before any cabling is drawn in.

Provision for drainage of condensation shall be provided in accordance with the I.E.E. Regulations.

No conduit shall be installed in floor screeds, unless specifically stated.

Chasing of walls must be carried out in accordance with the Structural Engineer's recommendations where appropriate. Under no circumstances shall horizontal chases exceed 500mm in length. Back to back chasing is also not permitted.

Where conduits, trunking and tray is supported from, fixed to the chill enclosure they shall be a minimum distance from the rear of the containment to the surface of the insulated panel of 25mm. This is to ensure cleaning behind the distribution is possible.

For trunking and tray with widths greater than 100mm, a 50mm gap shall be provided.

All screw fixings penetrating the skin of the enclosures shall be sealed with Water Research Council approved sealant.

2.4.15 Flexible Conduit

Where metal conduit is specified, flexible conduit shall be of the interlocked steel tape type with a PVC sheath to BS 731. Terminations shall be by means of compression glands.

An appropriately sized, insulated circuit protective conductor shall be drawn into the tubing and connected to earth terminals at each end.

2.4.16 Cable Trunking

For general purpose, cable trunking shall conform to BS 4678, Part 1, Class 3 galvanised. The gauge of the trunking shall be, 1.2mm up to and including 150x50mm, all other sizes up to and including 150x150mm shall be 1.6mm thick sheet steel. Where larger trunking is specified, the gauge of the trunking shall be detailed elsewhere in the Specification or on the accompanying drawings.

Trunking shall be properly aligned and covers closely butted and secured.

Manufacturers' standard accessories, e.g. bends tees, flares, etc., shall be employed throughout. Bends, Tees etc. shall be of the gusset or radius types.

Sections of trunking shall be bolted together by sleeve couplings and local copper supplementary bonding connectors. Where trunking with a painted finish is specified, the surface of the trunking shall be scraped clean at all jointing pieces and beneath earth bonding studs.

Multi-compartment trunking shall be welded internal fillets, and properly manufactured crossovers at junctions.

Cable retaining straps shall be provided at 750mm intervals wherever the cover is not on top.

For the support of cables, metal pin racks shall be fixed at 2m intervals inside trunking installed to guard against undue mechanical strain.

Where trunking passes through floors, ceilings and walls, the cover shall be cut and fixed to project 75mm either side of the obstruction. When the structure is made good, this section of cover will not be removable. Internal fire resisting barriers shall also be fitted.

Conduits shall be connected to the trunking by earthing sockets and male hexagon brass bushes. Insulated, single core earth continuity conductors shall be fitted.

Where multi-compartment trunking is required, the Contractor shall fix printed labels to each compartment side wall at 3m intervals to denote the use of the compartment.

2.4.17 Cable Tray

Cable trays shall be constructed of steel of minimum 18 SWG thickness, and shall be of the type and make specified in the particular clauses.

Standard accessories shall be used at each change in direction. However, where necessary, site cutting is permitted provided that all edges are cleaned up and painted before erection.

A minimum space between the building structure and tray of 50mm shall be allowed.

Cable tray shall be supplied and installed where more than two wire armoured or MICC cables share a common route.

Cables shall be fixed to the tray using proprietary straps, saddles or cleats as appropriate, at intervals specified in the I.E.E. Wiring Regulations for the type and size of cable.

Spacing of tray supports shall be in accordance with the manufacturer's recommendations.

2.4.18 Fixings and Fabrication

All steel screws, nuts, bolts and washers used for fixing ferrous materials to the building structure shall be sheradised. Non-ferrous fixings shall be employed when fixing non-ferrous materials.

Fixings to brickwork shall not be made in the mortar joint.

When fixing to structural steelwork, clamp-on devices shall be used unless otherwise approved.

Proprietary fixing devices shall be used throughout, e.g. Rawlbolts, Rawlplus, Plastiplugs etc.

Fixings inside dry partitions shall be by wood screws to timber blocks glued, using impact adhesive, to an internal face of the partition. Instruct the Builder on size and location of these timber blocks. Where necessary, provide extension rings for accessory boxes so that the edge of the box is just recessed.

All steelwork fabrications prepared shall be wired brushed to remove all scale and rust, treated with zinc chromate and painted with two coats of a rust inhibiting lead free primer.

All steelwork fabrications, cut-outs, etc., shall be smoothed free from all burrs or rough edges, and protection against abrasion to cables added where appropriate.

No welding to building steelwork or structures shall be permitted without the written consent of the Consulting Engineer/Contract Administrator.

Screws or studding shall, after installation, be reduced in length so that no more than two threads are exposed. All cut ends shall be treated with an approved rust inhibiting primer.

2.4.19 Wiring Grade Cables for Conduit or Trunking

For general wiring, the cable shall be 600/1000 Volt grade, single core, stranded copper with LSF insulation complying with BS 6004 or BS 6346.

Where LSF cables are specified in plantrooms, they shall be of the high temperature specification for operating at temperatures up to 80°C.

Where higher heat resisting grades of insulation are specified, silicone rubber insulated cables to BS 6007 shall be employed. Where the temperatures will not exceed 150°C such cables shall be identified throughout their length. For higher temperatures, cables shall have varnished glass-fibre insulation.

During installation, the cables shall be combed to facilitate drawing in and future replacement.

Inside trunking, cables forming final sub-circuits shall be tied together at 2m intervals to ease identification. The use of PVC self-adhesive insulating tape shall not be permitted for this purpose.

Cables shall be installed without joints.

Live conductors of lighting circuits shall be taken direct to switches, whilst associated neutral conductors shall be looped at lighting points, unless 4-terminal ceiling roses are specified elsewhere in this Specification.

Cables shall be colour coded in accordance with the I.E.E. Regulations.

In addition to phase identification, the cores of cables connecting control gear, thermostats, valves etc., shall be fitted with identification sleeves bearing the same markings as the terminals of the apparatus to which they are connected. All switch wires for lighting circuits shall be identified by means of an orange sleeve at each end.

2.4.20 Flexible Cords

Cords shall be 300/300 Volt or 300/500 Volt insulated and of conductor cross-section 1.0mm² or greater.

For connections to terminals of lamp holders and heaters, cores shall be glass-fibre insulated glass braid/varnish sheathed for a service temperature of 180°C.

For applications where the temperature does not exceed 60°C, cords shall have LSF insulation and sheath.

Proprietary brass stuffing glands shall be used in all cases where flexible cables are used.

2.4.21 Low Voltage Power Cables

Low voltage power cables shall generally be wire armoured to BS 6346, BS 5467 or BS 6724, as detailed elsewhere in this Specification.

Cables shall be fixed to tray or direct to a surface using cable cleats. The intervals for fixing shall be as stated in the I.E.E. Regulations or as stated by the cable manufacturer where no regulation applies. Where fixed to cable trays, power cables having an overall diameter of 10mm or less may be strapped to the tray using PVC covered metal strip of appropriate colour fixed using brass pins and nuts.

At all terminations, the sheath and armour shall be secured by brass compression glands and of a type suitable for both cable and location. The glands shall be complete with both earthing tag and plastic shroud. Connections to the earthing tag shall be by brass nuts and bolts. At the point of termination for PVC SWA cables feeding any equipotential zone, the cable shall terminate in a BICC type BW gland with integral earth and 481AA insulated adapter. All glands shall be outdoor type suitable for prevention of ingress of water type E.W. complete with shroud.

Any underground jointing of PVC SWA cables required shall be achieved using proprietary resin joint kits manufactured by Messrs. BICC Limited or A.E.I. Limited.

Cores shall be phased out either coloured core insulation or coloured sleeve markers shall identify the phases.

Cables buried in the ground shall be in a trench 700mm deep with 100mm of sand laid in the bottom, the cable lid on the sand then covered with 150mm of sand. Interlocked arched based cable protection covers stamped 'Electric Cables' shall be placed over the full length of the route then backfilled with sifted earth, free from rocks and stones well rammed, and 200mm below finished ground level a 100mm wide PVC tape with the letters 'Electric Cables' stamped or printed overall, shall be laid the full length of the route and the ground the reinstated to existing ground level.

NOTE: Where groups of cables are installed in a common trench, cable protection covers are to be of sufficient width to cover all cables; this may be achieved using two or three rows of narrow tiles if required.

Cable markers, concrete block type, with inset label stating size and type of cable(s) and function(s), shall be placed in the route at the maximum of 50 metres apart, and at each change of direction with a minimum of two markers per route, and at entry to a building a pillar type marker giving the same information. The markers shall be block and pillar type 'Electric Cable' markers as H.J. Baldwin Ltd., with 'Traffolyte'.

The MEC shall provide all covers, markers, tapes, etc. The laying of sand, covers, tapes, concrete and markers shall be by the Main Contractor but the MEC shall ensure and be responsible for the compliance with requirements. Where a direct contract exists the Contractor shall be responsible for all provision and installation.

Prior to the cable(s) being laid the Consulting Engineer shall be informed and arrangements made for an inspection to be made at each stage.

Where cables are to be buried in water logged ground or have to cross streams, then cable with a polyethylene sheath shall be employed. The extent of any such cabling will be dictated by the proposed development and identified by the MEC.

Where multi-core cables are employed, each core shall be numbered and numbered markers at each end shall identify the terminal number of the equipment to which the core is to be connected.

Below the armour clamp of all terminations, a non-corrosive identification band shall be fitted giving details of the type and size of cable in 5mm stamped letters and figures.

Where power cables pass through walls or floors they shall pass through properly formed openings which shall be fire stopped after installation using a proprietary foam.

Where power cables are laid in a common trench with other services, particularly communication cables, there shall be a minimum separation of at least 300mm between these services.

2.4.22 Tamperproof Screws

In all areas, the proprietary fixings for any accessories etc. shall be replaced with tamperproof screws. The type of screw shall be offered for approval to the Consulting Engineer prior to ordering.

The tamperproof screws shall be used for all accessories, including shower heads, PIR's, all sensors and detectors, radiant panel joints and access panels, grilles, shower mixers etc.

Stainless steel tamperproof screws are to be provided in all wet areas, bathrooms, kitchens, en-suites etc.

2.4.23 Mounting Heights

The following heights shall be used as a guide unless otherwise stated. Refer to the current edition of the Scottish Government's Technical Handbooks and BS 8300: -

- Sockets and other low level devices: 450mm to bottom of device.
- Switches and the like: 1200mm to top of device.
- Controls, displays and the like requiring precise control: 750 – 1,000mm (TBC on site)
- Fire alarm Break Glass call points: 1,200mm to top of device

2.4.24 Testing

Conduits and cables shall be tested during the progress of the work before their concealment as follows: -

- Continuity of protective conductors and equipotential bond of conduit, metal sheaths etc.
- Continuity of current carrying conductors.

Immediately prior to completion and in the presence of the Engineer carry out the initial inspection and testing detailed in Part 7 of the 17th Edition of the Wiring Regulations.

Test results are to be documented on test charts containing the following information for each circuit: -

- Design current (IB).
- Earth loop impedance (Ze) at furthest point.
- Line neutral impedance at furthest point.
- Loop resistance (R1 + R2).
- Continuity of ring final circuit conductors.
- Insulation resistance readings.
- Polarity test.
- RCD test where applicable.

In addition to the aforementioned information, each chart shall contain details of the external characteristics appertaining to the distribution board.

2.4.25 Identification, Notices and Documentation

Labels shall be provided to indicate the purpose of switchgear and control gear, unless there is no possibility of confusion. Labels shall be manufactured from traffolyte and be bolted to equipment, unless otherwise specified.

Distribution board schedules and 'As fitted' drawings shall contain such information as is required to satisfy Clause 514-3 of the Regulations. In addition 'As fitted' drawings shall detail conduit runs giving sizes.

Operation and maintenance manuals shall contain the following items, as a minimum: -

- Print of each 'As fitted' drawing.
- Circuit Chart for each Distribution Board.
- Test Chart for each Distribution Board.
- Emergency Lighting Test Certificate/Record Sheet. (Where self-contained luminaries are employed one sheet will be required for each luminaire).
- NICEIC/IEE Test Certificate.
- NICEIC/IEE Completion Certificate.
- A schedule of manufacturers along with catalogue numbers of all equipment used.
- Operation and maintenance Instructions for all specialist equipment, provided in a hard backed ring binder or lever arch files, suitably labelled.

The quantity of 'As fitted' drawings required and Operation/Maintenance manuals shall be as set out elsewhere in this Specification. Note: All of the above documents and labels should be available at the time of testing.

The MEC shall supply and fit such notices as may be required by Regulations 514-4 to 514-8 inclusive.

2.5 INSPECTION, TESTING AND COMMISSIONING

2.5.1 Introduction

This Section of the Specification details the general requirements applicable to all inspection, testing and commissioning works, and shall be read in conjunction with the detailed requirements as specified.

The works shall be to the requirements of the Contract documents and to the satisfaction of the Client

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

2.5.2 Definitions

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

Consulting Engineer – Attingham Consulting Engineers Limited

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

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

2.5.3 Reference to Other Design Documents

This section of the specification shall not be read in isolation. It must be read in conjunction with the other sections of this specification, the drawings and other documents referred to therein.

The MEC is to ensure that his Commissioning Specialist has access to all of these and any other relevant documents during the tender and afterwards in the following construction phases.

2.5.4 Standards

All inspection, testing and commissioning works shall be installed in accordance with the current editions of all applicable Scottish Government's Technical Handbooks, BS/EN and CIBSE/BSRIA/CSA standards, the most notable of which are listed below. These shall be a guide to the MINIMUM standard required and shall be overridden by the standards referred to in the rest of this specification and associated drawings.

- Current Scottish Government's Technical Handbooks
- CIBSE Commissioning Codes
- BSRIA Guides
- Commissioning Specialists Association Guidance

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

2.5.5 Scope of Work

The MEC shall allow to undertake all commissioning work as detailed in this Specification and as follows: -

- All management and advice activities during design, installation, pre-commissioning, commissioning and verification stages of the project. The management activities shall be compliant with the guidance given in the CIBSE Commissioning Code M and BSRIA AG5. The commissioning activities shall be fully integrated into the construction process from the point of appointment of the MEC, right through handover and beyond to fine tuning the building services during occupation.
- Early involvement in the project to advise on the commissionability of the building services design, whether that design is by the Consulting Engineer or the MEC. It is essential that this activity is undertaken in a timely manner to ensure that the systems can be commissioned satisfactorily without delay or additional cost.
- Oversee all pre-commissioning activities carried out by the installers as prescribed in the aforementioned commissioning guides and as specified in this and other sections of the specification and drawings. This includes overseeing and verifying the commissioning activities of specialist plant items such as chillers, boilers, DX cooling systems, BEMs etc. which are often specialised in nature and are commissioned by the manufacturer. The commissioning of specialist equipment, such as those aforementioned, especially where they integrate with the air and water distribution systems, shall require careful consideration and integration within the commissioning plan.

- All physical works involved in all commissioning activities including setting to work and dynamic proving in order to achieve the design intent. This includes returning to site for balancing and regulation adjustments during the maintenance period. Performance tests on heating and air conditioning systems shall be undertaken in peak weather conditions, irrespective of when completion takes place.
- Demonstration to the Consulting Engineer, of a proportion of final system flow rates.
- Provision of all necessary documentation including test records, commentary, diagrams, and reports for the MEC's manuals.
- Give notice to the Building Control Body or Local Authority declaring that a commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard; and the results of the tests confirm that the performance is reasonably in accordance with actual building designs, including written commentaries where excursions are proposed to be accepted.

The MEC shall allow for all costs associated with the above and the foregoing being included within his tender price.

The MEC shall also include for all fees charged by the Nominated or other Insurance Companies for all supervision and examination at the manufacturers' works during construction of all pressure vessels and similar equipment and the witnessing of works tests in addition to site tests and the incidental work involved. Two copies of all test certificates shall be supplied to the Commissioning Specialist.

2.5.6 Energy Efficiency

All commissioning shall be carried out in such a manner as to minimise the operating costs for the end user whilst fully complying with the design intent of the systems, i.e. reducing the speed of fan motors shall be done in preference to closing down dampers.

2.5.7 Commissioning Specialist

All commissioning works detailed in this Specification, and in particular this section of the Specification, shall be someone with relevant training and experience, and who is a full Corporate Member of the Commissioning Specialists Association.

The MEC shall state, at the time of tendering in the Specification Tender Analysis, the name of the Commissioning Specialist who will carry out the work. Alterations/changes of Commissioning Specialist, from those listed in the Tender Return, shall not be accepted without prior agreement by the Consulting Engineer and documented evidence giving reasons for change.

2.5.8 Commissioning Management

Unless specified otherwise, the MEC shall manage his own commissioning activities, establish clear lines of communication and be responsible for ensuring the commissioning is completed in accordance with this specification and the agreed programme.

2.5.9 Health and Safety

The MEC has a duty under the CDM Regulations to review the commissioning plan and bring any safety matters to the attention of the Client and/or Contract Administrator. Any actions resulting from this Health and Safety review shall be confirmed and managed by the Client and/or Contract Administrator prior to any commissioning work being undertaken. The MEC should be aware of the general risks associated with building services and be conversant with applicable legislation.
Reference should be made to CSA TM/5 Health & Safety Legislation Affecting Commissioning and the Safety sections contained within the relevant commissioning codes.

2.5.10 Witnessing and Verification

Witnessing and verification of tests will be required to enable confidence to be established for the commissioning results. Unless specified otherwise, the witnessing and verification will be undertaken by the Consulting Engineer. The proportion of tests to be witnessed by the Consulting Engineer will be 20%, though this could be reduced to 10% at the discretion of the Consulting Engineer on very large systems. The Consulting Engineer has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful. In this instance the MEC shall bare all additional costs associated with this additional work. The MEC shall inform the Consulting Engineer of the verification programme who shall at his discretion invite the Client representative. The MEC shall obtain counter signatures on all commissioning sheets to obtain certification that the results are within tolerance. No re-writing of test sheets shall be permitted following witnessing by the Consulting Engineer.

2.5.11 Commissioning Programme

The MEC shall produce a detailed commissioning programme. Where a Main Contractor is involved, the MEC's programme shall be fully integrated into the master construction programme. The commissioning programme shall be developed at the same time as the installation programme to ensure that the requirements for commissioning are incorporated in the construction activities.

The commissioning programme shall be broken down into individual services including sub contract works and shall include but not be limited to the following tasks: -

- Review design drawings and specifications for commissioning requirements (commissionability).
- Review installation drawings and technical submissions for commissioning requirements.
- Review the installation for compliance with specifications and drawings intent for commissioning.
- Produce detailed commissioning method statements.
- Testing and pre-commissioning.
- Off-site testing of plant items.
- Pipework system cleaning and dosing.
- Pressure testing of ductwork where applicable.
- Setting to work of plant systems and commissioning and performance testing.
- Open system scans.
- Demonstration of flow rates to the Consulting Engineer.
- Soak tests.
- Prepare testing and commissioning reports.
- Statutory demonstrations of life safety systems, to building end user and statutory authorities.
- Prepare and complete the relevant sections of the Building Logbook.
- Prepare final record documentation.
- Prepare and submit the commissioning completeness notice to Building Control.
- Training and awareness sessions with the building owner/user.

The commissioning activities shall be fully co-ordinated within the programme by the MEC. The MEC shall indicate the resourcing requirements within the programme tasks. The programme shall show critical activities and milestones to enable focus to be maintained on these items in order to minimise the risk of delay. The commissioning programme shall be submitted to the Consulting Engineer no later than 4 weeks after the date of contract commencement, for approval. The dates involved will be kept within the periods originally computed for testing and subsequently inserted as part of the 'Programme of Works'.

Following completion and approval of this programme, the MEC shall review the programme in relation to the construction progress at the regular site attendance meetings. The testing will proceed on the dates given but not less than 14 days following the notification to the Consulting Engineer of the state of readiness.

All Specialist Sub-Contractors and Specialist Suppliers to the MEC must note that they shall attend promptly on the times and dates stated. Failure to do so will result in the Schedule being extended and any parties failing to attend will be responsible for reimbursing the other parties involved for loss of time.

Notification of the testing programme commencement will not be less than l4 days and no cancellations will be allowed.

2.5.12 Design Familiarisation

Immediately following appointment and prior to works commencing on site the MEC shall: -

- Inspect the design drawings and this specification in order to fully familiarise himself with all the engineering services to be commissioned.
- Be fully satisfied that all necessary provision has been made for commissioning of the services including items such as volume control dampers, commissioning stations and pressure stabilising valves.
- The MEC shall issue a report to the Consulting Engineer to include: -

The details of any additional items that the MEC considers should be included.

Any further information needed to complete the installation.

Detailed testing and commissioning program for the works.

2.5.13 Contractor's Working Drawings

Prior to submission of any working drawings to the Consulting Engineer for approval, the MEC shall verify each drawing for commissionability. This shall include: -

- Correct positioning and accessibility of all controls, detectors, valves, dampers, items of equipment.
- Correct location and orientation of ductwork access panels.
- Indicate on all ductwork drawings the position of all test holes required.

2.5.14 Review Site Visits

During the installation of the contract works the MEC shall continually monitor the commissionability of every aspect of the services detailed in this specification. This shall include ensuring that all commissioning stations are installed in accordance with the manufacturer's instructions and all other items are installed in accordance with the approved working drawings and are fully accessible. Any aspect of non-compliance shall be corrected by the MEC at his own expense prior to commissioning works being undertaken.

A written log of all static tests audited shall be kept by the MEC for inspection by the Consulting Engineer.

As a part of the on-site inspections, the MEC shall ascertain that all aspects of the services can be fully maintained after handover. A report shall be issued to the Client and Consulting Engineer detailing any item that cannot be fully maintained.

2.5.15 Commissioning Records and Test Sheets

The MEC shall ensure that accurate records are taken for all checks and measurements undertaken within the commissioning scope of works. The records shall be completed at the time of undertaking the commissioning activity and should include any additional commentary that will support the understanding of the results, either later in the commissioning programme, or in the future after the building has been in operation for some time. It is essential that this anecdotal information is included as it will help future fine tuning of the services and enable informed decisions to be made during building modifications and improvements.

Standard commissioning pro-forma checklists shall be used to record the results. These shall be based on the criteria and templates in the relevant BSRIA Application Guides listed earlier in this specification. The MEC shall issue the proposed pro-formas to the Consulting Engineer for approval prior to undertaking any testing. The completion of these pro-formas should be completed only once (i.e. not subsequently transcribed by typing since this can lead to errors being introduced).

The design of the pro-forma shall be well thought out in order to: -

- Aid the efficient execution of the commissioning tasks.
- Help the control of quality and progress of the commissioning tasks.
- Provide a convenient means of comparing test results within design values.
- Serve as a permanent record of commissioning data to be included in the project's operating and maintenance manual.

2.5.16 Calibration of Instruments

The MEC shall ensure that the instruments used have been correctly calibrated and produce documentation to this effect. Calibration must be carried out against laboratory standards which are either traceable to National Standards or have been derived by approved ratio techniques.

The calibration certificates should include the following details: -

- Name of Calibration Laboratory.
- Name of Equipment Manufacturer.
- Equipment Model.
- Serial Number of Equipment Being Calibrated.
- Date of Manufacturer.
- Date of Calibration.
- Period of Validity of Calibration i.e. date for next re-calibration.
- Deviation table where applicable.

If the Consulting Engineer has any doubt about the accuracy of any instrument, the MEC shall have the instrument re-calibrated by a recognised Specialist. A current calibration certificate shall be provided for all instruments used during the commissioning. The certificate must cover the duration for which the instrument is used.

2.5.17 Method Statements

The MEC shall be responsible for compiling detailed commissioning method statements for all systems detailed in this Specification. This shall include obtaining method statements from all specialist sub-contractors and suppliers of plant and equipment being installed on this contract, and amalgamating them into an overall method statement to provide a fully co-ordinated document for each service (including controls).

The document shall be sectionalised for each system to clearly indicate the work which will be carried out for pre-commissioning, commissioning and performance testing.

2.5.18 Inspection of Materials

The Consulting Engineer shall be entitled at all reasonable times during the manufacture, to inspect, examine and test the materials and workmanship of all plant to be supplied under this Specification and if part of the said plant is being manufactured on other premises, the MEC shall obtain permission to inspect, examine and test as if the said plant were being manufactured on the MEC's premises.

Such inspection, examination or testing if made shall not absolve the MEC or release him from any obligation under this Specification.

Written notice shall be given to the Consulting Engineer of the date on which, and the place at which any plant will be ready for testing, and unless the Consulting Engineer shall attend at the place named within 10 days of the date which has been stated in his notice, tests may proceed which shall be deemed to have been made in the Consulting Engineer's presence, and the MEC shall forthwith forward to the Consulting Engineer duly certified copies of the test reading. The Consulting Engineer shall give twenty four hours' notice in writing of his intention to attend the tests. Such tests shall however, normally be attended solely by the MEC and his Commissioning Specialist.

Where the Specification provides for tests at outside premises, the MEC, except where otherwise specified, shall provide free of charge, such assistance, labour, materials, electricity, fuel, stores, oils and grease specified by the manufacturers, apparatus and instruments as may be required and as may be reasonable to carry out such tests efficiently.

If, after inspecting, examining, or testing the plant, the Consulting Engineer shall decide that such plant or any part thereof, is defective, and not in accordance with the Specification, he may reject the said plant or any part thereof by giving, within reasonable time, notice in writing of such rejection stating therein the ground upon which the said decision is based.

At the commissioning and practical completion time of the Contract, all moving parts shall be adjusted and lubricated in accordance with the manufacturers' instructions, including the filling of oil wells, greasing of bearings, adjustment of belts, alignment of couplings, etc.

2.5.19 Tolerances

All systems should be regulated to tolerance bands to ensure that they meet the design intent.

Systems shall be commissioned in accordance with the tolerances detailed in the following table except where more stringent requirements are detailed in the specific sections of this specification / drawings. Where a tolerance is not defined in the Tender documents the levels within the CIBSE commissioning codes shall be used for tender and confirmed with the Consulting Engineer before commencing work. Should the MEC be unclear of the performance effect (Low, Med, High) of the systems within this specification then he shall seek advice from the Consulting Engineer.

For most heating and chilled water applications, the Performance Effect shall be considered as Medium and the tolerances are summarised in the table below. For close control air-conditioning the performance effect is high.

For a proportional balance to be achieved on water systems, the upper and lower tolerance levels should not be exceeded. The index leg shall not be less than the minimum value and the remainder of the proportional balance should be achieved within the overall tolerance and should aggregate to at least 100%.

The following table shows permissible tolerances for the most common applications for water and air systems. The Commissioning Codes W and A should be referred to for all other applications. This table is to be read along with the associated notes and conditions of use within those Codes.

Commissioning Tolerances		
Component Description		Flow rate tolerance (% of design)
LTHW heating systems where flow / return temperature difference ≥ 11K, performance effect Medium.	Terminal units where flow rate <0.100 l/s (e.g. radiators & FCU's)	90 – 110%
	AHU coils where flow rate >0.1 l/s	92.5 – 107.5%
	Branches	92.5 – 107.5%
	Main Ducts	100 – 110%

2.5.20 Pressure Testing

The MEC and his Specialist Sub-Contractors shall undertake hydraulic and or pneumatic pressure testing of pipework in accordance with the relevant standards and this Specification. The Consulting Engineer shall review the testing method, check instrument calibration, witness the test and counter sign the test certificates. The MEC shall inform the Consulting Engineer of any test failures.

2.5.21 Hydraulic and Gas Tests

All hydraulic and gas tests shall be carried out before insulation is applied. The hydraulic tests shall be applied after all entrained air has been eliminated from the system under test. The following hydraulic test pressures and times shall be applied: -

Service	**Pipework Material**	**Test Pressure (bar gauge)**	**Test Time (hours)**	**Notes**
LTHW Heating and Chilled Water	Steel / Copper	5	6	
Domestic Services	S/S & Copper	7	6	
Natural Gas (above ground)	Steel / Copper	In accordance with current gas regulations and H&S approved Plastic code of practice.		
	Plastic			

Where working pressures vary from those detailed above, the test pressure shall be equal to twice the working pressure. Test pressures on mains cold water services shall in addition be agreed with the Local Water Authority.

The pressure gauge used shall be fitted at the furthest point away from the pump of the section under test.

All pumps shall be tested at the specified duty in accordance with BS 599 and BS 1394. Performance curves shall be forwarded to the Consulting Engineer with the Test Certificates.

Any defect identified during any of the tests shall be made good and the installation re-tested until the whole is free from defect and in complete working order to the satisfaction of the Consulting Engineer.

On completion of the work or any section as may be directed by the Consulting Engineer, all heating and domestic hot water installations shall have a circulation test carried out and all circulations shall be regulated to ensure that the temperature rises evenly throughout, and leave each installation ready for use to the satisfaction of the Consulting Engineer.

Natural gas pipework shall be tested in strict accordance with the requirements of British Gas, Safe Gas and the IGE.

2.5.22 Flushing and Chemical Cleaning

The MEC pipework shall flush and chemically clean all piped services conveying water, i.e. LTHW Heating, Chilled Water, Domestic Services etc. All works shall be carried out in accordance with the relevant governing documents, BSRIA Application Guide AG1/2001 - Pre-commissioning and Cleaning of Pipework Systems and this specification.

The MEC shall issue a report to the Consulting Engineer detailing any non-compliance issues.

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

Flushing of the system shall: -

- Be completed in accordance with the described guides and method statements.
- Continue until satisfactory cleanliness is achieved as defined in the described guides.

- Be witnessed by the Clerk of Works or Commissioning Specialist.
- Recorded by the MEC and certified by the Clerk of Works or Commissioning Specialist.
- Be completed in the absence of any filters, meters, circulating pumps, traps, valves, controllers, non-return valves and items of equipment which may be damaged or prevent adequate flushing, all of which shall be removed during the flushing process by the MEC and re-instated upon completion.

Samples shall be taken 7 days after treatment from representative points in each system to ensure that the treatment has been successful.

An analysis of these samples shall be undertaken by an Independent ACAS accredited laboratory at the MEC's expense.

No system shall be left charged with untreated water for a period in excess of 48 hours, where this period is exceeded the BSRIA recommendations with regard to biocides and cleansing etc. shall be followed in full at the MEC's own expense. If treatment process proves unsuccessful the Consulting Engineer shall instruct for repeat treatment at the MEC's expense.

Chemical cleaning of the system shall: -

- Be completed in accordance with the described guides and method statements.
- Continue until satisfactory cleanliness is achieved as defined in the described guides.
- Be witnessed by the client
- Recorded by the MEC and certified by the client.
- Be completed in the absence of any filters, meters, circulating pumps, traps, valves, controllers, non-return valves and items of equipment which may be damaged or prevent adequate flushing, all of which shall be removed during the flushing process by the MEC and re-instated upon completion.

2.5.23 System Additives

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

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

- Be adequately sized for the system (10 litres minimum).
- Be a proprietary pre-fabricated unit with fill funnel, drain and service valves that shall be positioned in a location agreed by the Consulting Engineer.
- Be provided whether indicated on drawings or not.

The treatment shall be introduced by means of a prefabricated purpose made dosing pot with fill funnel, non-return fill valve, drain and service valves that is to be positioned in a location agreed by the Consulting Engineer.

The MEC shall include for all associated costs irrespective of whether this item is indicated on the Tender Drawings. The dosing pot shall be assumed to be at a distance of 5 metres from its system connection point.

2.5.24 De-Aeration

Removal of air from the system is an ongoing process which shall be continued by the MEC until all air has been removed.

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

- On a continuous basis during the system fill period and for at least 4 hours thereafter.
- Immediately prior to commencement of commissioning and on a daily basis during commissioning.
- Twice a day for the first seven days after the system has been filled.
- On a weekly basis until no air is released for two consecutive weeks.

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

2.5.25 Sterilisation of Domestic Services

On all projects the MEC shall: -

- Fill, pressure test and flush the system using water from an appropriate source, for example: -
  - Mains water supply
  - Temporary site supply

Potable drinking water bowser

- Sterilise the complete system including pipework, tanks etc. in accordance with the British Standard defined in the standards section of this specification. HTM requirements shall also be adhered to on all healthcare and related projects.
- The Consulting Engineer shall be notified 48 hours prior to sterilisation taking place so that arrangements can be made to witness the procedures.
- Provide and maintain safety labels and signs in accordance with the British Standard and as follows: -

Warning signs at every outlet during chlorination process.

Warning signs at principle drinking water points and common area such as site canteen / office / entrance stating water on site is not suitable for drinking, these signs to be maintained until satisfactory laboratory results are obtained.

- After completion of the sterilisation, maintain the service in safe condition by regular flushing out of the systems, until the date of Practical Completion (twice weekly flushing routine for entire system including hose reels etc. formally recorded and witnessed by the Clerk of Works or the Commissioning Engineer). Calculate the water capacity of the various sections of the systems and the amount water to be drawn off to ensure that completely fresh mains water is drawn into the system twice weekly.
- Should twice weekly flushing not be adequately completed the system shall be re-chlorinated and sample taken / analysed.
- Provide certification showing the areas/sections treated and the levels of chorine solution used.
- Take samples upon completion of sterilisation and obtain laboratory analysis which shall be taken at representative locations throughout each system as follows: -
  - Incoming mains supply.
  - Furthest point on each system (e.g. DHW, MCW, BTCW etc.)
  - Each storage tank (where fitted)
  - In agreed locations throughout the remainder of the systems at the rate of one sample per 20 outlets (or pair of outlets where serving WHB or the like).
- All samples shall be analysed by a UKAS accredited laboratory in accordance with British Standards and Public Health Laboratory Recommendations, including an E.Coli, chemical analysis, copper content, lead content and Legionella test.. Analysis of results and clear statement with regard to suitability for human consumption.
- Allow for nearly issue of results (before Legionella results are available) where required by local authority in order to connect the new mains water supply.
- In the event of any of the test results not being acceptable, the MEC shall flush out, re-chlorinate and re-test as previously specified at no additional cost to the contract.
- Practical completion of the works shall not be given until chlorination is complete and full satisfactory laboratory results have been obtained.

The MEC shall employ a water treatment specialist to carry out the sterilisation works.

2.5.26 Commissioning of Equipment by Manufacturers

Specialist plant and equipment shall be inspected / commissioned by the manufacturer's competent person and a full commissioning report provided and included in the O&M documentation. The following plant shall be commissioned by the manufacturer: -

- All variable speed pumps.
- Boilers.
- Automatic controls and BMS/BEMS systems.

The MEC shall include the commissioning period of all specialist plant and equipment within his plan and ensure that the coordination and timing of these activities fits in with the main commissioning programme and ultimately the construction programme. The MEC shall obtain the commissioning report and verify that all the checks have been completed and signed off, with the system being safe, prior to setting them to work as part of the overall building services systems.

2.5.27 Performance Testing and Seasonal Commissioning

Performance tests on heating and air conditioning systems shall be undertaken in peak weather conditions, irrespective of when completion takes place. This is specifically the case with refrigeration machinery which shall be testing during peak load conditions during high ambient temperatures.

Seasonal commissioning of all systems shall take place during the first year of occupancy, under actual occupancy conditions, during extreme weather conditions. The ventilation, heating and lighting systems are to be checked at 3, 6 & 9 monthly intervals by measurement and occupancy feedback.

The MEC shall allow for providing heat loads within the space to replicate the actual system maximum cooling loads to test plant under full load conditions. The MEC shall allow for portable electrical heaters and temporary wiring for this facility.

The test head load shall be calculated in kW by the air volume in m^3/sec in the particular space multiplied by a factor of 11.0.

2.5.28 Test Certificates

On completion of each test the MEC shall provide the Consulting Engineer with duplicate copies of a test certificate. The certificate shall be signed by the MEC and shall, where applicable, be countersigned by the Consulting Engineer to signify that the test has been witnessed.

Each test certificate shall give particulars of the following:-

- The item of equipment or section or installation or system under test together with its location.
- The manufacturer's reference number (where applicable).
- The date of which the test was carried out.
- The names of the parties who were present when the test was carried out.
- The nature, duration and conditions of the test.
- The type of test instruments used.
- The result of the test.

No test shall be considered valid until the MEC provides the Consulting Engineer with the relevant test certificate.

Duplicate copies of test certificates for tests carried out by manufacturers at their works shall be forwarded to the Consulting Engineer for approval prior to despatch of the manufactured item or items to the site.

2.5.29 Documentation for O&M Manuals

The MEC shall provide the commissioning documentation listed below for inclusion in the operating and maintenance documentation: -

- Fully signed masters and copies of all commissioning records and test sheets as detailed earlier in this Specification (Hard copy and PDF)
- Details of any amendments to the installed plant and equipment (e.g. changes to belt and pulley sizes).
- Details of any off site test sheets as detailed earlier in this specification.

The Commissioning Specialist shall be responsible for programming the progress of compilation of record drawings and manuals and shall ensure these are completed in their entirety prior to handover to the Client.

2.5.30 Test Schedules

The MEC shall carry out the following tests as a minimum: -

2.5.30.1 Test Schedule – Boiler Houses

- Check all controls for accuracy and setting.
- Check main panel for fixings and finish.
- Check all pumps, mountings, belts, etc.
- Check belt drives for alignment and tensioning.
- Check all motorised valves for operation.
- Check all thermostats controlling mechanisms for correct operation.
- Check all valve charts, instruction booklets, tool kits, etc., are already for handover.
- Generally check whole installation within boiler house for pipe fixings joints, valves, etc.

- Check pipework for identification sleeves etc.
- Check the whole of the boiler house for complete lagging.

2.5.30.2 Test Schedule – Cold Water Service

- Check all draw-off points at wash basins.
- Check all draw-off points at sink units.
- Check all supplies at shower units, WC's urinals, etc.
- Check pipework runs for brackets, fixings, etc.
- Check all mixing valves for operation.
- Inspect Test Certificates/Analysis of water supply.
- Check all identification labels and bands.
- Check installation and fixing of hose reels.
- Check cold water temperature at all draw off points after running individual outlets for 120 seconds. Tabulate all results.

2.5.30.3 Test Schedule – Fuel Gas Installation

- Check all gas taps for operation.
- Check all controls, governors, gas valves, etc., for operation.
- Check all pipework, fixing, brackets, etc.
- Check all labelling, pipework identification, etc.

2.5.30.4 Test Schedule – Thermostats

- Check that thermostats are in correct location.
- Check for operation.

2.5.30.5 Test Schedule – Control Panels

- Check for operation of all run and trip lights.
- Check labelling of panel for accuracy.
- Check on finish and fixing.
- Check general condition of panels, wiring, earthing lugs, etc.
- Check overloads for accuracy of operation.

SECTION 3

PARTICULAR REQUIREMENTS

CONTENTS

3.1 GENERAL

3.1.1 General Scope

The works consist of the replacement of the existing boiler plant located in the External Plantroom at the following address: -

Centre for Ecology and Hydrology
Bush Estate
Penicuik
Midlothian
EH26 0QB

The works shall generally consist of the following: -

- Decommissioning and stripping out of all redundant services
- New Mechanical Services as detailed herein
- Test and commission
- O&M manuals and as-installed drawings
- Demonstration of the services to the end user

The MEC shall supply, coordinate, prepare working drawings, install, test and commission all services as detailed herein. The MEC shall provide all necessary plant, materials and sundries in order to provide a fully complete and working installation.

3.1.2 Approved Contractors

The MEC must be able to demonstrate reasonable competence and experience of carrying out work of a similar scope, value and complexity, and must be able to fully resource the necessary skills and labour to carry out the works.

The MEC shall be approved by a recognised body and confirmed in writing to the Consulting Engineer. Generally this recognised body shall be NICEIC for Electrical Contractors (Commercial) and Safe Gas and B&ES for Mechanical Contractors.

In addition, the MEC will be required to successfully complete the Client's approval and tendering processes. Please contact the Client for details of these criteria.

3.1.3 Tender Queries

Any queries that the MEC has during the tender period shall be directed to UK Shared Business Services immediately.

The MEC shall NOT make direct contact with the Client.

3.1.4 Site Visit

The MEC shall note that site visits are a requirement during the tender period.

The MEC shall ensure that they understand the works, working area and limitations of the site and all existing services. No claims will be accepted for unforeseen works as a result of not making due allowance for working and altering existing services, plant and associated works

3.1.5 Form of Contract and Main Contract Preliminaries

The Client's form of contract shall be NEC 3 Engineering and Construction Short Contract'.

Please contact the Client for exact details of the Form of Contract and/or Preliminaries.

3.1.6 Programme of Works

The start and completion dates date shall be as the Contract.

General daily working hours shall be agreed with the Client.

The MEC shall agree the exact sequence of works with the Client prior to works commencing.

3.1.7 Named Suppliers and Sub-Contractors

Where suppliers and/or sub-contractors are named within this specification, the MEC shall be aware that alternative suppliers and/or sub-contractors can be used, provided that the alternative(s) are equal and of at least the same quality, efficiency, protocol, performance and standard as the item selected within the design as specified.

3.1.8 Installation of Plant

All plant shall be installed in strict accordance with the manufacturer's instructions. The MEC shall allow for all works associated with these instructions.

Any discrepancies between the manufacturer's instructions and the works detailed herein shall be brought to the immediate attention of the Consulting Engineer.

3.1.9 Coordination

The MEC shall be responsible for coordination the entire M&E Services works.

All details indicated on the drawings are for tender purposes only and shall be verified on site by the MEC where accuracy is critical. The exact location of all plant items/equipment and the route of all services shall be determined on site. The successful MEC shall, on being awarded the project, be required to provide working coordinated drawings for review by the Consulting Engineer within five working days of receipt of order.

The final positions of all plant, services and controls shall be approved by the Client and/or Consulting Engineer prior to installation.

The MEC shall allow for changes in distribution system(s) invert levels (including any sets up and down etc.) as necessary to coordinate fully with the building structure and other M&E Services.

The MEC shall prepare working drawings for comment and review by the design team (Consulting Engineer, Client etc.) prior to procurement of sub-contract work, plant etc., and prior to works commencing on site.

3.1.10 Asbestos

During the works, should the MEC identify any materials which they consider may contain asbestos, they shall cease works in that vicinity immediately and shall inform the Client at the earliest opportunity.

A full refurbishment and demolition level asbestos survey has been completed and copies of the report are available on site to view.

3.1.11 CDM Regulations

The MEC will be the **PRINCIPAL CONTRACTOR** for the works and shall be responsible for all matters regarding the Construction Design & Management Regulations (2015 edition) for the project, including consideration for future demolition, adaptation and extension.

CEH will be the **CLIENT** for the works.

CEH will be the **PRINCIPAL DESIGNER** for the works.

The MEC shall plan, manage, monitor and coordinate health and safety in the construction phase of a project. This shall include: -

- Liaising with the Client and Principal Designer;
- Preparing the construction phase plan;
- Organising cooperation between contractors and coordinating their work.

The MEC shall ensure: -

- Suitable site inductions are provided;
- Reasonable steps are taken to prevent unauthorised access;
- Workers are consulted and engaged in securing their health and safety; and
- Welfare facilities are provided.

Before commencement of site works, the MEC shall carry out and/or provide the following: -

- Complete and submit the F10 form to the HSE (if required)
- Three copies of the construction stage Health and Safety plan.
- Three copies of Method Statements and Risk Assessments for dealing with specific operations, i.e. lifting of major plant, working at height, working in confined spaces, break-ins to existing services etc.

For information, further guidance on CDM duties can be found in HSE Guide L153 “Guidance on CDM 2015 Regulations”.

3.2 SCHEDULE OF TENDER-ISSUE DRAWINGS

3.2.1 General

The drawings listed below form part of this tender document; if any drawings are missing or not clear, you should contact UK Shared Business Services immediately.

Note: The drawings are colour coordinated and may only be reproduced in the original colours.

The drawings shall be read in conjunction with the relevant specifications and all relevant Engineer's drawing(s).

All details indicated on the drawings are for tender purposes only and shall be verified on site by the MEC where accuracy is critical. The exact location of all plant items/equipment and the route of all services shall be determined on site. The successful MEC shall, on being awarded the project, be required to provide working coordinated drawings for review by the Consulting Engineer.

3.2.2 Drawings

The drawings scheduled below have been produced specifically for this project.

Drawing Number	Revision	Title	Paper Size
0747 56-601	T1	Proposed Heating & Gas Layout	A1
0747 56-602	T1	Proposed Heating & Gas Schematic	A1

3.3 ENABLING WORKS

3.3.1 General

The existing boiler plant within the External Plantroom shall generally be decommissioned and stripped out. This shall include the following: -

- 6 No. Hamworthy Wessex 100NG gas-fired boilers, arranged in a 3 wide x 2 high modular assembly. Equivalent and compatible boilers would be acceptable though supplier needs to fully demonstrate compatibility with the specification.
- Boiler combustion exhaust flues.
- Boiler shunt flow pipework, from the redundant boiler to the inlet of the air/dirt separator.
- Boiler shunt return pipework, from the outlet of the heat meter to the redundant boiler plant.
- Dosing pot pipework.
- Natural gas pipework, from the outlet of the sub-meter to the redundant boiler plant.
- HVAC Controls and associated power and controls wiring serving the above redundant plant.

3.3.2 Services and Plant to be Retained and Re-Used

The MEC shall note that all other plant, pipework, controls and wiring within the External Plantroom is to retained and put back into full working order.

3.3.3 Stripping Out of Existing Services

All redundant mechanical services which are not required to be reused for the revised layout and rendered redundant under this scheme are to be removed from their present location and disposed of in accordance with current statutory regulations. This shall be carried out by the MEC, once authorisation has been confirmed that isolation may take place.

The MEC shall visit site during the tender period and make all due allowances for building restrictions and service implications so that all costs can be included within the tender to cover the full extent of the works associated with the stripping out. No additional monies will be available for failure to comply with this request.

The MEC shall allow for all necessary tools, labour, materials, general equipment, access equipment and any subcontracted works to undertake all necessary removal works, including but not limited to the following: -

- Identify all services to be removed and become conversant with the distribution and existing installation and site, in order that isolation and removals may be undertaken with the minimum disruptions to other connected services. Particular care shall be taken where services are to be reused to ensure that all equipment and supplies are reinstated to provide similar facilities within the existing building(s).
- Isolate, drain down and make safe all piped services and equipment to be removed. Fit plugged valves to new branch service connections in order that connected supplies may be reinstated and branch connections extended at a later date if required.
- Refill, vent and purge the connected services to remain and ensure that systems are reinstated to all areas and functioning correctly. This may entail works outside of the general working areas and will require rebalancing of circuits.
- Allow for localised adjustments and rebalancing, where applicable, of the existing LTHW heating system as a result of the services modifications and removals.
- Remove all redundant pipework, fittings, brackets, insulation and all associated equipment, fittings, controls, control sensors, valves etc.
- Remove all redundant controls, controls field devices (sensors, valves, actuators etc.) and associated power wiring and controls wiring (including containment).

The MEC shall obtain permission from the Client prior to isolating any services or interrupting any supplies. The MEC shall submit isolation request and obtain hot work permits prior to commencing isolation/removals works.

The MEC shall provide all necessary protection to building surfaces and equipment to be reused. The MEC shall be liable for any damage caused during the removal, transportation and reinstatement works associated with this contract. The MEC shall ensure all residual water in circuits is removed before dismantling piped services.

The MEC shall allow for all costs associated with isolations and works taking place outside of normal working hours where affecting other areas outside of the general working area.

3.3.4 Redundant Materials

The MEC shall allow for the safe removal of all redundant plant items and associated materials from site.

Prior to disconnection the MEC shall establish in consultation with the Client if any items or components are required to be retained for spares or future use. All items identified shall be carefully removed, cleaned and handed over to the Client.

All redundant plant items and associated materials shall be periodically removed from site. Items awaiting removal shall be assembled in a safe manner and in an agreed location so as not to affect the functioning of the site, or progress of work on the site.

Where functional systems are to be extended or modified the MEC shall allow for isolating the respective systems and verifying that it is safe to proceed with the scheduled works.

The MEC shall allow for the provision of all skips and the safe and proper disposal of all redundant plant and materials, all in accordance with current statutory regulations. Copies of all certification for the proper disposal of all waste shall be provided to the Client.

Where necessary, the MEC shall arrange for the removal and transportation of all redundant electrical plant to an authorised Waste Electrical and Electronic Equipment (WEEE) recycler at an Approved Authorised Treatment Facility (AATF), where it shall be dismantled in such a way that any hazardous substances are destroyed or reprocessed.

3.3.5 Use of Cutting Equipment

The removal of pipework shall be either by simple mechanical disconnection or, where this is not possible, via cutting tools such as disc cutters.

To avoid potential fire risks, oxyacetylene cutting/torches will only be permitted with prior approval and when no other method can be adopted.

Prior to any such work the fixed fire detection system must be isolated with prior notification and agreement of the Client.

Adequate ventilation must be maintained at all times.

3.3.6 Isolation Procedures

Service isolations shall only take place with the approval of the Client. The following procedures shall be carried out prior to service isolation: -

- The MEC shall fully survey the areas affected by the works and this may extend into areas outside of the work place where common systems serve other areas.
- Existing commissioning settings shall be taken (LTHW Heating) so that the modified systems can be put back into balance.
- The route of services and extent of interruptions shall be established together with the location of isolating valves, if available.
- The MEC shall make a formal application requesting a services interruption/shut down. The application must also include a cause and effect schedule to cover the following: -
- Service to be isolated.
- Day/time of requested isolation.
- Duration of isolation.
- All areas affected.
- A minimum of 7 working days will normally be required. It is essential that the service isolations are planned well in advance of the required work to allow full consultation with both the Client and Consulting Engineer.
- Having obtained permission to isolate services, the MEC shall be responsible for verifying the extent of disruptions by isolating circuits **OUTSIDE OF NORMAL WORKING HOURS** to ensure that valves hold and the cause and effect information of areas affected is correct.
- NOTE: Where isolations affect areas outside of the contract, these works may only take place outside of normal working hours. All costs associated with additional labour costs shall be included for by the MEC.
- All isolations and modifications shall be pre-planned, labour resourced and materials obtained to ensure interruptions are kept to a minimum in certain instances more than one work team may be required.

- General work may take place during normal working hours and to suit the programme; however, for tender purposes the MEC shall allow for all isolations to be carried out outside of normal working hours so as not to affect the areas outside of the contract working areas which will remain functional throughout the contract.
- Upon completion of the works, the existing circuits and supplies shall be reinstated.

The MEC shall check all services, branches and outlet points connected to the modified services and ensure all systems are fully reinstated, re-commissioned and balanced. This may require venting/purging, balancing of areas outside of the work place and may require rebalancing of existing and new circuits and duct sections.

3.3.7 Temporary Boiler Plant

The MEC shall allow for the provision of temporary boiler plant during the works, to ensure continuity of use of the heating system for the Client.

The temporary boiler plant shall be located externally in the vicinity of the adjacent building. Temporary pipe connections shall be made into the flanged pipe flow and return connections located in the concrete chamber adjacent to this building.

The temporary boiler shall be rated at 500kW output and shall be trailer-mounted. The plant shall be housed in a sturdy vandal proof aluminium container on a high speed trailer. The bunded gas oil storage tank shall be located in the container.

The MEC shall allow for the temporary electrical supply to serve the plant.

The MEC shall allow for the supply of all gas oil during the hire of the plant. The MEC shall allow for a total usage at tender stage of 8,000 litres.

Fig. 1 – Suggested Location of Temporary Boiler Plant

Fig. 2 – Suggested Location of Temporary Pipe Connections

3.4 LTHW HEATING

3.4.1 General

The MEC shall install the new LTHW Heating plant within the External Plantroom, all as detailed herein and as indicated on the drawings.

3.4.2 Existing Services

It shall be assumed at tender stage that the existing LTHW Heating installation throughout the remainder of the building is in good condition and can be re-used. Any defects to the pipework shall be brought to the immediate attention of the Client.

3.4.3 Existing Boiler Plant

The existing 6 No. Hamworthy Wessex 100M natural gas-fired boilers (arranged in a 3 wide x 2 high modular assembly) shall be de-commissioned and stripped out.

Please refer to Section 3.3 for further details.

3.4.4 New Boiler Plant

3 No. new floor-mounted, fully modulating, low NOx, stainless steel, condensing modular boilers shall be installed.

Each boiler shall be a Hamworthy Wessex ModuMax Mk3, model ref. 97/194V, with a rated heat output of 191.4kW and a seasonal efficiency of 94.98%. An Equivalent and compatible manufacturer would be acceptable though supplier needs to fully demonstrate compatibility with the existing boiler house configuration and specification requirements.

Each boiler shall be supplied with the matching optional LPB bus communications module.

Each boiler shall also be supplied with the matching pre-assemble pipe header kit. Each kit shall include the following: -

- Isolating quarter-turn ball valves, with operating handles, for water flow and return connections on each boiler module
- Flow and return flexible connectors and tees
- Drain valves
- Flow and return header pipe assembly
- Gas manifold (supplied loose)
- Blanking flanges, gaskets and bolts for header ends
- Adjustable levelling feet

The MEC shall be aware that alternative suppliers can be used, provided that the alternative(s) are equal and of at least the same quality, efficiency, protocol, performance and standard as the item selected within the design as specified.

The drain lines from the condensate connections shall be routed to discharge safely over the nearest floor gulley.

The boilers shall be commissioned by the manufacturer. The boilers shall be commissioned to provide a flow temperature of 82°C and a return temperature of 71°C, i.e. a differential of 11K.

3.4.5 Boiler Combustion Flues

A new combustion exhaust flue system shall be installed to serve the 3 No. new boilers.

The flue to each boiler shall discharge to atmosphere at roof level via an anti-downdraught cowl. The flue installation shall be installed in strict accordance with the boiler manufacturer's installation instructions, BS 6644, BS 7566 and BS 5440 and The Clean Air Act.

All flue components within the Plantroom shall be twin-wall insulated type with grade 316 stainless steel inner liner, 25mm thick dense insulation annulus and grade 304 stainless steel outer liner. The design of the flue lengths and components shall allow the inner liner to freely expand without affecting the performance of the flue and associated joints.

All flue components routed within the chimney shall be 0.5mm thick grade 316 stainless steel (single skin, no insulation), fully welded throughout, with internal silicon gaskets.

All flue lengths and fittings shall be arranged to ensure that any condensate does not leak out from the joints. Support brackets shall be stainless steel. All joints shall be fitted with a locking band.

3.4.6 Boiler Safety Valves

Each new boiler shall be fitted with a new high-lift type safety valve.

Each valve shall be a 25mm NB Nabic fig. 500 (high lift pattern). The discharge set pressure shall be 3.2 bar.

The MEC shall be aware that alternative suppliers can be used, provided that the alternative(s) are equal and of at least the same quality, efficiency, protocol, performance and standard as the item selected within the design as specified.

The drain line from each safety valve connection shall be routed to discharge safely over the nearest floor gulley.

3.4.7 Pressurisation Unit

The existing packaged pressurisation unit shall be retained and re-used.

For information, the existing unit is an Aquatech model ref. AQUAPACK SP2ET-P4-05-0-E with REFIX DE-06G-1220-50028 500-litre expansion vessel.

The unit shall be re-commissioned by the manufacturer.

3.4.8 Dosing Pot

The existing dosing pot shall be retained and re-used. The unit shall be taken down and re-fixed to enable installation of the new boiler plant.

For information, the existing unit is a Jet size 3.

The 25mm flow and return pipe connections shall be modified and extended to suit. The connections to the main heating pipework shall be provided with isolating valves and unions.

3.4.9 Air/Dirt Separator

The existing air/dirt separator shall be retained and re-used.

3.4.10 Boiler Shunt Circuit Pumpset

The existing boiler shunt twin-head pumpset shall be retained and re-used.

For information, the existing pumpset is a Grundfos TPED100-60/14 with integral inverter drives.

The pump shall be re-commissioned to provide a flow rate of 13.200l/s.

3.4.11 Glass Houses CT Circuit Pumpset

The existing twin-head pumpset serving the Glass Houses CT circuit shall be retained and re-used.

For information, the existing pumpset is a Grundfos MAGNA D32-120F with integral inverter drives.

The pump shall be re-commissioned to provide a flow rate of 1.670l/s.

3.4.12 1970s Building VT Circuit Pumpset

The existing twin-head pumpset serving the 1970s Building circuit shall be retained and re-used. For information, the existing pumpset is a Grundfos MAGNA D50-120F with integral inverter drives. The pump shall be re-commissioned to provide a flow rate of 5.500l/s.

3.4.13 Cairngorm Building VT Circuit Pumpset

The existing twin-head pumpset serving the Cairngorm Building circuit shall be retained and re-used.

For information, the existing pumpset is a Grundfos MAGNA D32-120F with integral inverter drives.

The pump shall be re-commissioned to provide a flow rate of 0.700l/s.

3.4.14 Heat Meter Assemblies

The existing heat meter assemblies shall be retained and re-used.

3.4.15 System Filling Loop

The existing filling loop shall be retained and re-used.

3.4.16 Flushing and Dosing of System

After completion of the new heating system installation (including pressure testing), the heating system shall be dynamically flushed by the MEC to remove, where practical and reasonable, all sediments and deposits. A chemical flush is not required.

Once the system has been flushed, filled and vented by the MEC, it shall then be dosed with a suitable corrosion inhibitor by a specialist sub-contractor.

3.4.17 Pipework and Fittings

All tube of sizes 15 to 50mm NB shall be black heavyweight mild steel to EN10255 with screwed and socketed ends and red primered finish. All tube of sizes 65 to 150mm NB shall be black heavyweight mild steel to EN10255 with plain ends and red primered finish (15 to 50mm NB).

Please refer to the General Requirements section of this specification for further details.

3.4.18 Pipework Installation Requirements

All plant items shall be fitted with isolating valves to allow maintenance/replacement works to be carried out without draining down the system.

All low points shall be fitted with a lockshield draincock. Where possible, the system shall be vented via the radiators at upper floor levels; where this is not possible, automatic air vents shall be fitted.

3.4.19 Pipework Thermal Insulation

All pipework located internally shall be thermally insulated with pre-formed mineral wool sections with Class 0 foil cover.

Insulated valve covers shall be fitted throughout. These shall be of the removable flexible bag type with Velcro and cord fastenings.

Thicknesses and thermal conductivities shall comply with the current Scottish Government's Technical Handbooks and BS 5422: 2001.

3.5 NATURAL GAS SERVICE

3.5.1 General

The MEC shall modify and extend the Natural Gas Service, all as detailed herein and as indicated on the tender-issue drawings.

All gas works shall be carried out by a Gas Safe registered Person in full accordance with the Gas Safety (Installation and Use) Regulations, BS6798, BS5449, BS5546-1, BS5440-2 and BS6891. All components shall be certified for use with natural gas.

3.5.2 Incoming Service

The existing incoming natural gas service to the Boiler House shall be retained and re-used.

3.5.3 Sub-Meter

The existing sub-meter shall be retained and re-used.

3.5.4 Emergency Shut-Off Valve

The existing emergency shut-off solenoid valve shall be retained and re-used.

3.5.5 Emergency Knock-Off Button

The existing emergency knock-off button shall be retained and re-used.

3.5.6 Electro-Thermal Links

The existing 3 No. electro-thermal links shall be retained and re-used. These shall be repositioned to suit the new boiler plant.

3.5.7 Pipework and Fittings

All tube routed above ground of sizes 15 to 50mm NB shall be black heavyweight mild steel to EN10255 with screwed and socketed ends and red primered finish. All tube of sizes 65 to 150mm NB shall be black heavyweight mild steel to EN10255 with plain ends and red primered finish (15 to 50mm NB).

Please refer to the General Requirements section of this specification for further details.

3.5.8 Pipework Installation Requirements

All items of plant shall be fitted with isolating valves, and effective means of commissioning and purging, to enable inspection and/or maintenance works to be carried out without purging the entire system.

Isolating valves, purge points and test points shall be fitted as necessary to comply with current guidelines and legislation.

All new pipework shall be fully identified in strict accordance with current statutory requirements and guidelines, in particular IGE/UP/2 Edition2 Clause 7.8.4.

3.6 DOMESTIC SERVICES

3.6.1 General

The MEC shall modify and extend Domestic Cold Water Service, all as detailed herein and as indicated on the tender-issue drawings.

All plant items and components shall be suitable for conveying wholesome (potable) water, shall be WRC / WRAS approved and shall comply with The Water Supply (Water Fittings) (Scotland) Byelaws 2014.

3.6.2 Existing Services

It shall be assumed at tender stage that the existing Domestic Services installation is in good condition and can be re-used. Any defects to the pipework shall be brought to the immediate attention of the Client and Consulting Engineer.

3.6.3 Notification of Works with Local Water Authority

The Water Supply (Water Fittings) (Scotland) Byelaws 2014 are national requirements that are aimed at protecting water supplies. They provide information enabling the correct installation, maintenance and use of water fittings. Prevention of waste, misuse, undue consumption, contamination and errors in the measurement of water supplied by the water supplier are the key aims. To enable the various local Water Authorities to effectively enforce the regulations, installers should be aware of these regulations and the need for advanced notification for certain types of plumbing work.

The MEC shall provide all information required by the local Water Authority (contact details, installer details, site details, description of works, drawings, schematics, plant and equipment details etc.).

It is a criminal offence to start work without notification and consent.

3.6.4 Incoming Mains Cold Water Service

The existing incoming mains cold water service to the Boiler House shall be retained and re-used.

3.6.5 Pipework and Fittings

Unless stated otherwise, all pipework shall be copper tube to EN1057-R250 table X with Geberit Mapress copper fittings (standard black CIIR Butyl Rubber seal rings).

3.6.6 Pipework Installation Requirements

All plant items shall be fitted with isolating valves to allow maintenance/replacement works to be carried out without draining down the system.

All low points shall be fitted with a lockshield draincock.

All pipework passing through walls and floor slabs shall be sleeved. All pipes passing through fire compartment walls and floor slabs shall also be fire stopped.

3.6.7 Thermal Insulation

All pipework located internally shall be thermally insulated with pre-formed mineral wool sections with Class 0 foil cover.

Insulated valve covers shall be fitted throughout. These shall be of the removable flexible bag type with Velcro and cord fastenings.

Thicknesses and thermal conductivities shall comply with the current Scottish Government's Technical Handbooks and BS 5422: 2001.

3.7 ABOVE GROUND DRAINAGE

3.7.1 General

All sanitary pipework and drainage installations shall satisfy the relevant requirements of the Building Standards (Scotland) amendment regulations 1982. Installations shall also be carried out in strict accordance with BS EN 12056:2 Code of practice for sanitary pipework.

Pipe gradients shall be between 1 and 5 degrees with a maximum distance of 3 metres. Branch pipe distances over 3 metres shall be avoided wherever possible since they are prone to blockage.

The drain line from main plant relief valves shall be routed to discharge safely over the nearest floor gulley.

The condensate lines from the new boilers shall discharge over the nearest floor gulley. The exact method and discharge position shall be agreed with the Consulting Engineer prior to installation.

3.7.2 Working Temperatures

Standard PVC systems may be used to convey liquids with a maximum temperature of 76°C when subjected to continuous flow. Intermittent discharges of up to 100°C may occur provided they are of less than 2 minutes duration.

For tender purposes, it shall be assumed that the above ground drainage system operates within these parameters. Where temperatures are deemed to exceed these limits, then the Consulting Engineer shall be consulted for alternative approaches.

3.7.3 Intumescent Sleeves

Intumescent sleeves shall be fitted to all soil and waste pipes 40mm NB and above passing through a fire-rated structure. All sleeves shall provide 4 hours fire resistance in accordance with BS 476 Part 20: 1987 and shall be fixed in strict accordance with the manufacturer's instructions.

3.7.4 Access

Sufficient and suitable access must be provided to enable all pipework to be tested and maintained effectively. Access covers, plugs or caps shall be installed in positions to facilitate use of testing equipment and removal of blockages. Access points shall be provided on all soil stacks at each floor level, including ground floor, and shall be positioned at 600mm AFFL to the centre-line. Access points shall be either by means of an integrally moulded door or by a two-piece door, with integral clamp, fitted directly into the pipe.

3.7.5 Ventilation

Each discharge stack shall be ventilated in order to prevent pressure building up within the system and drawing the water seals in the traps. The highest point of the below ground drainage system (commonly termed the head of the drain) shall be vented to atmosphere at roof level. All other stacks shall be ventilated via an automatic air admittance valve.

3.7.6 Thermal Expansion

Adequate allowance shall be made for thermal movement. This shall be achieved by fitting an expansion ring seal joint between two fixed solvent-weld joints. The expansion gap shall be created by pushing the spigot fully into the ring seal socket, and marking the position at the socket face, then withdraw the spigot by 10mm. The MEC shall check subsequently to ensure that the expansion gap is not lost during further installation work.

Expansion joints shall be provided at a maximum of 4.0m centres for soil, 2.0m centres for waste and between fixed points over 1.0m centres.

3.7.7 Pipework and Fittings

Unless indicated otherwise, all above ground drainage pipework shall not be resistant to acid.

All pipework 19mm NB shall be PVC-u with solvent weld fittings to BS 4514:1983 and BS EN 1329-1:2000 (Terrain Overflow System 500 or equal and approved).

All pipework 32mm to 50mm NB shall be MuPVC with solvent weld fittings to BS 5255:1989 (Terrain Waste System 200 or equal and approved).

All pipework 80mm to 160mm NB shall be PVC-u with solvent weld fittings to BS 4514:1983 and BS EN 1329-1:2000 (Terrain Soil System 100 or equal and approved).

All appliance waste traps shall comply to BS 3943:1979 (Terrain System 400 or equal and approved). Each trap shall provide a 75mm deep water seal trap and be of the anti-syphon type to ensure adequate ventilation of the branch pipe.

All pipe and fittings shall be colour grey to BS 5252:10.A.07. All solvent weld cement shall comply to BS 6209.

All automatic air admittance valves shall be covered by a current British Board of Agrément certificate. Terrain types 153.3.4 and 253W or equal and approved.

All piped services shall be installed in strict accordance with the tube and fitting manufacturer's guidelines.

3.8 HVAC AUTOMATIC CONTROLS

3.8.1 General

The existing HVAC Automatic Controls system shall be modified as necessary to provide control and monitoring of the systems detailed herein, and to allow full monitoring and data collection.

The system shall be provided to enable the following functions: -

- Zone timeclock and temperature control of the building space heating installation.
- Control of the natural gas service.
- Data collection from the gas, water and LTHW Heating heat sub-meters.

The works shall comprise of the design, supply, installation, testing and commissioning of the building energy management system (BEMS).

The existing controls are CYLON,

All controls values (temperature setpoints, timeclock settings, alarm conditions etc.) shall be agreed between the controls specialist and the Consulting Engineer prior to commissioning of the system.

3.8.2 Controls Specialists

HVAC Automatic Controls systems shall only be installed by specialist contractors.

The specialist controls contractor must be able to demonstrate reasonable competence and experience of carrying out work of a similar scope, value and complexity, and must be able to fully resource the necessary skills and labour to carry out the works.

The specialist controls contractor shall also hold current trade approvals from the equipment suppliers.

For information, the existing HVAC control panel serving the pumps (and incorporating the Cylon “SiteGuide” LCD controller).

The MEC shall note that the Client’s preferred specialist controls contractors are the above two companies. The MEC shall be aware that alternative sub-contractors can be used, provided that the alternative(s) are equal and of at least the same quality, efficiency, protocol, performance and standard as the item selected within the design as specified

3.8.3 Front End Graphics

The specialist controls contractor shall allow sufficient time and resources to develop the controls strategy and front end graphics in conjunction with the Client. The presentation of the system usage and energy consumption data will be subject to particular scrutiny.

3.8.4 Electrical Installation

The HVAC Automatic Controls package shall include for the electrical installation associated with the control system. This shall include for the following: -

- Power wiring from the control panels to plant
- Controls wiring from the control panels to field controls
- Containment system for the installation
- Local rotary isolators for mechanical plant powered from the control panel
- Testing and inspection of the completed installation
- Supplementary earth bonding of the above

The following electrical installation shall not form part of the BEMS controls package (all presumed to be installed at present and in good working order): -

- Power supplies to the control panels
- Fire alarm interlink to the control panels
- Data point installation to the control panels

3.8.5 Existing Control Panels

The existing 2 No. control panels shall be retained and re-used. These shall be modified as necessary to suit the new boiler plant.

3.8.6 Existing Sub-Meters

The existing gas, water and LTHW Heating heat sub-meters shall be retained and re-used.

3.8.7 Brief Description of Services Operation

Detailed below is the brief description of operation of each service. The exact controls philosophy shall be agreed with the Consulting Engineer.

3.8.7.1 Frost Protection

Three-stage frost protection shall be provided as detailed below and shall remain operational at all times: -

- **Stage 1** - If the outside air falls below the outside frost set point during unoccupied hours then the duty pumps shall start and the motorised valves shall open.
- **Stage 2** - During stage 1 above, the minimum boiler return temperature shall be maintained above the boiler return frost set point of 25°C.
- **Stage 3** - At all times the internal space temperature shall be maintained, with the heating being enabled at 10°C and disabled at 12°C. All set points shall be adjustable between limits via the password protected keypad display unit or remotely via the central supervisor.

3.8.7.2 Optimised Start/Stop

Optimised start/stop control shall also be provided for the space heated areas to raise the internal occupancy temperature from the overnight setback condition to the occupancy set point. These temperature sensors shall also be utilised to provide internal frost protection for the building.

3.8.7.3 LTHW Heating Boiler Plant

The new gas-fired boiler plant shall be sequence-controlled and modulated by the controls system on demand from the building services and include new flow and return temperature sensors on the primary flow and return pipework.

The boiler control and limit thermostats shall be set up by the boiler manufacture and the control system shall take these into consideration when setting the system.

The boilers shall operate in conjunction with the primary circulation pumps and hard-wired safety interlocks as required.

Optimum start and stop features shall be available to ensure the internal temperature set points are achieved for occupancy times.

The boilers shall provide a running signal feed back to the BEMS controller so a true status can be displayed on the BEMS.

The boilers shall provide a running signal and a fault condition for monitoring by the BEMS controller and shall raise an alarm on the control panel when the preset values are exceeded.

3.8.7.4 LTHW Heating Boiler Primary Circuit

The existing boiler shunt circuit shall retain the existing twin-head, variable-speed pump, which shall be enabled via the BEMS controller on demand from that circuit and operation shall be monitored via a differential pressure transducer. The pump shall be controlled to provide constant volume.

A flow failure shall cause an alarm to be registered within the BEMS outstation and automatically enable the standby pump on twin pump arrangements.

Pump overrun shall operate the duty pump for a preset period of time to dissipate heat from the boiler primary circuit.

Weekly duty sharing shall also be carried out by the BEMS outstation, to even wear on each pump on twin pump arrangements.

In addition to the flow proving signal monitoring, the status of each motor protector shall be monitored by the BEMS to confirm starter operation and overload trip condition.

3.8.7.5 LTHW Pressurisation Unit

The LTHW Heating system shall use the existing pressurisation unit, which shall be monitored by the BEMS controller for both high and low pressure conditions.

During a fault condition on the pressurisation unit, an alarm shall be raised at the control panel and BEMS outstation and the boiler plant operation shall be inhibited.

3.8.7.6 LTHW Heating CT Circuit – Glass Houses

The existing CT Heating circuit serving the Glass Houses shall retain the existing twin-head, variable-speed pump, which shall be enabled via the BEMS controller on demand from that circuit and operation shall be monitored via a differential pressure transducer. The pump shall be controlled to provide variable volume at a constant differential pressure.

A flow failure shall cause an alarm to be registered within the BEMS outstation and automatically enable the standby pump on twin pump arrangements.

Pump overrun shall operate the duty pump for a preset period of time to dissipate heat from the boiler primary circuit.

Weekly duty sharing shall also be carried out by the BEMS outstation, to even wear on each pump on twin pump arrangements.

In addition to the flow proving signal monitoring, the status of each motor protector shall be monitored by the BEMS to confirm starter operation and overload trip condition.

3.8.7.7 LTHW Heating VT Circuit – 1970s Building

The existing VT Heating circuit serving the 1970s Building shall retain the existing twin-head pump, which shall be enabled via the BEMS controller on demand from that circuit and operation shall be monitored via a differential pressure transducer. The pump shall be controlled to provide variable volume at a constant differential pressure.

The circuit shall re-use the existing 3-port mixing valve, operated under the dictates of a weather compensation control strategy via an external temperature sensor and main pipework flow and return temperature sensors. When the ambient temperature is 0°C the flow temperature shall be 82°C; when the ambient temperature is 20°C the flow temperature shall be 20°C.

A flow failure shall cause an alarm to be registered within the BEMS outstation and automatically enable the standby pump on twin pump arrangements.

Pump overrun shall operate the duty pump for a preset period of time to dissipate heat from the boiler primary circuit.

Weekly duty sharing shall also be carried out by the BEMS outstation, to even wear on each pump on twin pump arrangements.

In addition to the flow proving signal monitoring, the status of each motor protector shall be monitored by the BEMS to confirm starter operation and overload trip condition.

Temperature sensor of the heating circuits shall be provided and recorded on the BEMS to ensure correct temperature conditions are being achieved and maintained.

3.8.7.8 LTHW Heating VT Circuit – Cairngorm Building

The existing VT Heating circuit serving the Cairngorm Building shall retain the existing twin-head pump, which shall be enabled via the BEMS controller on demand from that circuit and operation shall be monitored via a differential pressure transducer. The pump shall be controlled to provide variable volume at a constant differential pressure.

The circuit shall re-use the existing 3-port mixing valve, operated under the dictates of a weather compensation control strategy via an external temperature sensor and main pipework flow and return temperature sensors. When the ambient temperature is 0°C the flow temperature shall be 82°C; when the ambient temperature is 20°C the flow temperature shall be 20°C.

A flow failure shall cause an alarm to be registered within the BEMS outstation and automatically enable the standby pump on twin pump arrangements.

Pump overrun shall operate the duty pump for a preset period of time to dissipate heat from the boiler primary circuit.

Weekly duty sharing shall also be carried out by the BEMS outstation, to even wear on each pump on twin pump arrangements.

In addition to the flow proving signal monitoring, the status of each motor protector shall be monitored by the BEMS to confirm starter operation and overload trip condition.

Temperature sensor of the heating circuits shall be provided and recorded on the BEMS to ensure correct temperature conditions are being achieved and maintained.

3.8.7.9 Natural Gas Service to Plantroom

The existing electrically operated gas safety solenoid valve fitted to the incoming gas supply within the External Plantroom shall be retained and re-used.

The electrical supply to the solenoid valve shall be interlocked with the building fire alarm, the existing emergency stop push-button located near the door and the existing electro thermal links located over the gas-fired plant.

The existing 3 No. electro-thermal links shall be repositioned to suit the new boiler plant.

An alarm shall be raised at the control panel in the event of a gas valve close condition. This shall inhibit operation of the gas-fired equipment via hard-wired interlocks within the control panel.

3.8.7.10 Fire Alarm Interface

The BEMS shall be interfaced with the fire alarm system.

Upon activation of the fire alarm, the mechanical plant shall be immediately shut down. The plant shall not shut down when the fire alarm weekly test is run.

When the fire alarm is returned to normal status, all mechanical services shall be re-energised.

3.9 BUILDERSWORK IN CONNECTION

3.9.1 General

The MEC shall carry out all builders work in connection with the works detailed herein. These works shall generally consist of, but shall not be limited to, the following: -

- Temporary protection of the building finishes and fixtures during the installation and commissioning works.
- Making good the building fabric, including weatherproofing where necessary, after stripping out of the existing redundant services and installation of the new services.
- Carry out all wall chases and making good thereof.
- Carry out any penetrations through walls, floors & ceilings and making good thereof.
- Cleaning of the working area after each shift where the area is to be occupied or used by the End User.

The MEC shall be responsible for removing all redundant plant and waste from site, including the cost of skip(s) and waste disposal. All waste shall be disposed of in accordance with current regulations.

3.9.2 Modify Boiler Plinth

The MEC shall extend the existing concrete boiler plinth to suit the new boiler plant. The plinth shall be 50mm larger on all sides than the footprint of the new plant.

3.9.3 Boiler Flue Penetrations through Plantroom Roof

The MEC shall allow to modify as necessary the existing penetrations through the roof for the new 3 No. boiler combustion exhaust flues. The roof shall be fully weathertight upon completion of the works.

3.10 ELECTRICAL WORKS IN CONNECTION

3.10.1 General

The MEC shall carry out all electrical works in connection with the works detailed herein. These works shall generally consist of, but shall not be limited to, the following: -

- Provision of a temporary electrical supply to serve the temporary boiler plant.

- Taking down and reinstatement of all electrical items (including but not limited to luminaires, fire alarm devices etc.) as necessary to allow installation of the proposed services.
- Temporary support of any cabling, and associated services which are to be taken down and reinstated as part of the installation works.
- Temporary isolation of the fire alarm service, and bagging off of associated fire alarm detectors, as necessary to allow installation of the proposed services.
- Decommissioning, isolation and stripping out of all redundant electrical services.
- Containment system for the installation.
- Testing and inspection of the completed installation.
- Supplementary earth bonding as required by BS7671, On-Site Guide and all associated Guidance Notes.

3.10.2 Electrical Installation General Requirements

Please refer to the General Requirements section of this specification for further details.

3.11 INSPECTION, TESTING AND COMMISSIONING

3.11.1 General

All works shall be fully inspected, tested and commissioned in order to provide a complete and working installation. The works shall comply with the Preliminaries and General Requirements sections of the specification. Commissioning shall include the seasonal commissioning of all works.

All commissioning shall be carried out in such a manner as to minimise operating costs for the end user whilst fully complying with the design intent of the systems.

Please refer to the General Requirements section of this specification for further details.

3.11.2 Operating & Maintenance Manuals and As-Installed Drawings

The MEC shall provide a comprehensive O&M manual, incorporating as-installed drawings. The information shall comply with the Preliminaries section of the specification.

The MEC shall employ a specialist Sub-Contractor to produce 4 No. complete copies of the Operating and Maintenance manuals. The manuals shall cover the full scope of the services installed by the MEC and appointed Sub-Contractor(s), including any additional works installed during the contract period.

The manuals and as-installed drawings shall be produced in accordance with Class D of BSRIA Guide BG I/2007 “Handover, O&M Manuals and Project Feedback – A Toolkit for Designers and Contractors”.

Please refer to the General Requirements section of this specification for further details.

3.11.3 Piped Services Schematics, Valve Charts and Labels

A schematic drawing of each piped service (i.e. LTHW Heating, Domestic Services, Natural Gas etc.), shall be provided in each plantroom where that service is contained. Each schematic shall accurately detail the as-built pipework arrangement, including all associated plant, controls equipment and other ancillaries.

Please refer to the General Requirements section of this specification for further details.

3.11.4 Labelling of Plant and Equipment

Each item of plant and equipment shall bear a metal nameplate giving the manufacturer's name, serial number and relevant plant and equipment performance data. This nameplate shall be provided by the manufacturer at their works. In addition, traffolyte labels shall be neatly fixed to all items of plant and equipment, and shall be screwed or bolted on as necessary.

Please refer to the General Requirements section of this specification for further details.

3.11.5 Demonstrations

The MEC shall allow in their price for sufficient time to demonstrate and train the Client and end users on all items within the installation. Please refer to the General Requirements section of this specification for further details.

3.11.6 Schedules of Critical Spares

The MEC shall provide a schedule of critical spares to the Client. This schedule shall be incorporated into the O&M Manual.