SPECIFICATION FOR MECHANICAL SERVICES

—

EMMANUEL CHURCH
UPPERTON ROAD
EASTBOURNE
EAST SUSSEX

—

PREPARED FOR
EMMANUEL CHURCH

—

10 OCTOBER 2019
REVISION 0

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ISO 9001, OHSAS 18001

ISSUE SCHEDULE			
PREPARED BY: **DENNIS WILLIAMS**		CHECKED BY: -	AUTHORISED BY: -
DATE: **10 OCTOBER 2019**		DATE: -	DATE: -
REVISION	DATE	BY	DETAILS
0	-	DW	TENDER ISSUE

CONTENTS

1. GENERAL DESCRIPTION

.01 LOCATION OF THE SITE

Emmanuel Church, 46 Upperton Road, Eastbourne, East Sussex, BN21 1LP.

.02 GENERAL DESCRIPTION OF THE PROJECT

The construction of a 3 storey building to accommodate a new church and community rooms for Emmanuel Church, Eastbourne.

.03 NAMES OF PARTIES

Employer:	Emmanuel Church, 46 Upperton Road, Eastbourne, East Sussex, BN21 1LP.
Architect	CPL Architects, First Floor, Unit A3, Chaucer Business Park, Dixons Road, Polegate, East Sussex, BN26 6QH Tel: 01323 416900
Services Consultant:	MCA Services Consultants Ltd Unit 8 Newhouse Business Centre Old Crawley Road Horsham West Sussex RH12 4RU Tel: 01293 851490

.04 CONTRACT CONDITIONS AND DOCUMENTS

The successful tenderer will be appointed as a Domestic Mechanical Contractor to the Main Contractor and be contracted to work under the terms and conditions imposed upon the Main Contractor.

The Contract Documents shall comprise these conditions, with this Specification and the accompanying tender drawings and schedules, together with any other contract documents issued by the Main Contractor or Employer at the time of tender, or stated by them as forming part of the Contract Documents at the time of tender.

The Mechanical Contractor shall have satisfied themselves as to the location and access conditions prevailing to the Contract and shall enquire of the Services Consultant concerning any further details and necessary provisions affecting the costs before submitting their Tender. No extra will be allowable on account of inadequate provisions or inaccurate measurement on the part of the Mechanical Contractor.

It is a requirement of the Tender that no qualifications will be allowed, any discrepancies are to be highlighted during the Tender period to MCA and clarification requested.

.05 SCOPE OF WORKS AND RESPONSIBILITIES

.01 The Mechanical Contractor shall be responsible for the development of the design such as developing the pipework, ductwork, plant capacities, sizing checks and agreement on the location of any necessary commissioning valves required, co-ordination, preparation of working drawings, supply, delivery, detailed on site co-ordination, site installation, testing, commissioning and putting to work, handover and warranty of all of the systems described in this document and on the drawings.

.02 The Mechanical Contractor shall be responsible for checking the proposals put forward in the tender documents and shall bring to the attention of the Services Consultant any discrepancies, anomalies or errors contained therein that may reasonably be found within the tender period, so that any necessary alterations may be included within the tender sum.

.03 The Mechanical Contractor shall be responsible for the preparation of all builder's work information necessary for the installation of those services that they are to install, and for the preparation of drawings for approval of wiring, control panels, ductwork and any other item requiring site dimensions or specialist manufacture.

.05 On completion of the works, the Mechanical Contractor shall be responsible for instructing the Client in the full use of the services that they have installed, and for producing a complete set of Record Drawings, Operating Instructions and Maintenance Manuals which shall be approved by the Services Consultant before issue to the Client.

.06 Should the Mechanical Contractor require additional information to complete their design development/working drawings, they shall notify the Services Consultant in reasonable time for this to be produced with sufficient time to meet the design programme. No delays for late receipt of design information will be accepted if the Mechanical Contractor fails to allow sufficient time for this operation.

.07 The Mechanical Contractor shall provide full installation details and equipment technical submissions for comment by the Services Consultant, these are to be provided in sufficient time to meet the contract programme, and it must be noted that the Services Consultant will require 7 full working days for the process of review and comment.

.08 Where water, gas and/or electrical supplies are already on the site, and the Mechanical Contractor shall check the location of these supplies to familiarise themselves with them, and their means of isolation.

.09 Design and installations to be provided by the Mechanical Contractor are as follows:

- New incoming mains gas supply,
- New gas distribution system
- New gas boiler plant and LTHW distribution systems,
- New underfloor heating systems,
- Primary LTHW heating to new HWS Calorifiers,
- Passive ventilation systems,
- Mechanical ventilation systems
- New incoming mains water supply,
- New mains water distribution system,
- New domestic hot water generation and distribution system,
- Thermal insulation,
- New internal above ground drainage systems,

- New control systems and electrical wiring,
- Building Energy Managements System,
- Electrical works in connection,
- All necessary flushing, cleaning and water treatment,
- Testing and commissioning,
- Handover
- Record Documentation,
- 12-month warranty.

.10 The Mechanical Contractor shall be responsible for liaising with other trades as to the sequence of works to prevent any delay to the programme which may be caused by such a lack of understanding of the complete installation.

.11 The Mechanical Contractor will be working for the Main Contractor, who will be providing general attendance for all other parties on site. The Main Contractor will also be responsible for site safety, site security and temporary lighting. All other necessary specialist attendance shall be provided by the Mechanical Contractor.

2. GENERAL TECHNICAL REQUIREMENTS

.01 SUB-MECHANICAL CONTRACTOR LABOUR

The Mechanical Contractor shall not use labour not in their direct employ for any part of this Contract without prior written permission of the Services Consultant.

Any complete specialist works within this Contract comprising the supply of material and labour may only be sub-contracted by the Mechanical Contractor with written permission from the Services Consultant.

.02 ASBESTOS REGULATIONS

The Mechanical Contractor shall ensure observance with the Health and Safety at Works Act and, in particular, the regulations concerning asbestos.

The Mechanical Contractor shall be responsible for ascertaining the presence of all asbestos, issuing the statutory notice to the Health and Safety Executive, ensuring the safety of the general public and the protection of all operatives under their direction by proper protective clothing, respirators etc., and correct disposal arrangements.

The Mechanical Contractor's Tender for this contract shall be deemed to include all costs associated with compliance with the above Asbestos Regulations.

.03 GENERAL REGULATIONS

The components and installation shall comply with the recommendations and requirements (as applicable) of the British or European Standard Specifications and Codes of Practice, the requirements of the Water and Electrical Supply Authorities and any other Authorities or Insurance Companies concerned with the Works.

All work installed under this Contract shall conform to the Water Supply and all other relevant authorities' Regulations and the Electrical/Mechanical Contractor shall be responsible for any fees payable to these authorities for the inspection and stamping of valves, electrical tests etc.

The Electrical/Mechanical Contractor shall notify appropriate Supply Authorities prior to any tests to be witnessed by those Authorities and following those tests, shall render the tested system fully operational by flushing, chlorination and/or other appropriate procedures.

The whole of the installation and all electrical work appertaining to it must be carried out in strict accordance with the latest edition of The Institution of Electrical Engineers Regulations for the Electrical Equipment of Building, and all current amendments as issued by the Institution of Electrical Engineers, henceforth referred to as the IEE Regulations; also to the requirements of the Insurance Companies, interested Local Authorities, Electricity Boards and other parties concerned. Where PME conditions apply, the earthing/bonding arrangements shall accord with the Supply undertaking requirements.

.04 DURATION OF WORKS

The works covered by this Specification shall be carried out in whole or in part, as may be required, either to suit the building programme or to the specific requirements of the Employer, as stated on the Tender Form.

The Mechanical Contractor shall visit the site when called upon to do so, for setting out details and/or carrying out of works, whether their men are employed at the site or not at the time.

The Mechanical Contractor shall, before tendering, examine the drawings, Specification, Conditions

of Contract, Schedules, etc., and shall fully acquaint themselves with local site conditions.

Detail drawings and sections of the building may be inspected at the offices of the Architect by appointment. The Mechanical Contractor shall have no claim because of want of knowledge in any respect of the Sub-Contract.

.05 BUILDER'S WORK

All builder's work information shall be provided by the Mechanical Contractors to the Main Contractor in a format acceptable to the latter, and in a time to suit the programme of works.

This shall usually take the form of detailed drawings showing bases, trenches, ducts, holes, supports, etc., although marking these directly on site will be permissible if acceptable to the Main Contractor. These drawings shall, where relevant, be based on the respective manufacturer's certified drawings, and shall be submitted to the Services Consultant for comment prior to issue for construction. The Mechanical Contractor shall be totally responsible for the preparation of all such information and its continued accuracy and shall ensure that their requirements do not clash with those of other Contractors. Should such a situation occur, the Mechanical/Main Contractor shall bring this to the attention of the Services Consultant for comment.

Where any Builder's work Drawings are provided by the Services Consultant these shall be checked by the Mechanical Contractor and details of additional Builder's works required shall be submitted by the Mechanical Contractor in an approved form to the Services Consultant for approval before issue to the Main Contractor.

Any building work carried out incorrectly due to faulty setting out or late provision of details on the part of the Mechanical Contractor shall be re-executed by arrangement with the Main Contractor without further cost to the Employer.

.06 SITE MEASUREMENT

All dimensions and clearances affecting the installation of work shall be verified on site in relation to established datums, to building openings and to the work of other trades.

Should interferences occur which will necessitate deviations from the layout or dimensions shown on the Drawings, the Services Consultant shall be notified and any changes approved before proceeding with the work.

The Mechanical Contractor shall prepare Working and/or Shop Drawings for services based on checked site dimensions, and actual Shop Drawings prepared by other disciplines. All dimensions and levels on Services Drawings have been based on information to hand at the preparation of these Drawings and may need adjustment before ductwork can be manufactured or pipework pre-fabricated. Should any such adjustments be necessary, the Mechanical Contractor shall notify the Services Consultant.

Where necessary, and in the case of all components of proprietary origin, including ductwork, switchgear and control panels, Shop Drawings of components or equipment shall be provided by the Mechanical Contractor at their own cost. All such Drawings shall be subject to the approval of the Services Consultant, and no work contained on such Drawings shall be executed until approval of the drawings has been obtained. Such approval shall not relieve the Mechanical Contractor of their full responsibility for the work carried out.

Such Drawings shall include complete data on the equipment, including physical dimensions and other information required for installation, performance capabilities and limitations, and schedules indicating locations when more than one type of an item is to be used. All Shop Drawings must be certified as being correct for the proposed work.

Shop Drawings, brochures or catalogue sheets showing more than one size shall be marked to indicate the size or model proposed for the particular application. Prior to submittal, Shop Drawings shall be fully co-ordinated with the work of all other trades.

Shop Drawings submitted for approval shall be identified as to the specific equipment for which the Shop Drawing relates. Identification shall be by reference to equipment numbers as shown on the Drawings or by reference to the appropriate clause of the Specification in which the equipment is specified.

The Mechanical Contractor is advised that the drawings have been based on known equipment selected at the Design Stage to meet the technical requirements of the systems, and the Mechanical Contractor shall therefore only base their Working / Shop Drawings on the equipment they have selected and make the necessary modifications to ductwork and pipework services.

The Mechanical Contractor shall record all variations and omissions on duplicate sets of the Contract drawings, one copy of which shall be kept on site. The Mechanical Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied whether such drawings and particulars have been approved by the Architect or not, provided that such discrepancies, errors and omissions are not due to inaccurate information or particulars furnished in writing to the Mechanical Contractor by the Design Team.

.07 APPROVED MANUFACTURERS

Approved manufacturers shall be as indicated, but not limited to, those named in the various sections of this Specification and/or Schedules. However, the tender must be based on the specified manufacturers, and alternatives offered must be detailed in a covering letter, with financial implications.

Alternatives to those manufacturers named may be considered, provided the Mechanical Contractor can show to the Services Consultant that the alternative proposed will meet exactly the technical and aesthetic requirements of the equipment selected, and be of comparable quality to that called for in this Specification and Drawings.

The Mechanical Contractor's attention is drawn to the possible physical limitations which may restrict the use of some alternative equipment brought about by the building structure, with respect to height, width, length and access required for routine maintenance of the equipment concerned.

.08 PURPOSE-MADE EQUIPMENT

The Mechanical Contractor shall provide the Services Consultant with details of all purpose-made equipment prior to manufacture, in the form of detailed drawings, particularly ductwork, switchgear and control panels, for inspection and comment.

.09 DELIVERY OF MATERIALS

The Mechanical Contractor shall be responsible for the cost of unloading, placing in and removal from store, craneage and hoisting of materials and plant for which they are responsible.

The Mechanical Contractor shall allow, where necessary, for protecting the building where hoisting and lifting of plant and materials takes place.

Should any of the materials specified for this Contract be subject to delivery delays outside the control of the Mechanical Contractor, which do not suit the programme of Works, the Mechanical Contractor shall submit to the Services Consultant details of those delays and details of alternative equipment obtainable within the required Programme.

.10 CO-ORDINATION

The Mechanical Contractor shall be entirely responsible for co-ordinating their site works with other trades. This includes the provision of precise details of the electric wiring required to equipment under this contract, where such wiring is to be carried out by others.

The costs of any delays to any other party to this contract occasioned by the Mechanical Contractor's failure to satisfactorily co-ordinate and liaise their works shall be borne by the Mechanical Contractor.

Where drawings or details relating to such co-ordination have been prepared by the Services Consultant, the Mechanical Contractor shall check these and notify the Services Consultant of any errors in these drawings or details. Failure to do so will not alleviate the Mechanical Contractor's responsibility for co-ordination.

.11 WORKMANSHIP

The Mechanical Contractor shall ensure that only the highest standards of workmanship are used for these works. The achievement of this standard shall be at the sole discretion of the Services Consultant whose decisions in these regards shall be final.

Should the Services Consultant decide that the required standard of workmanship has not been provided, the Mechanical Contractor shall arrange to correct the shortcomings and replace defective material or labour at their own expense and without delay to the progress of the works.

All welding shall only be carried out by operatives who hold current Certificates of Competency as issued by the Heating, Ventilating and Domestic Services Consulting Employers' Association.

The Mechanical Contractor shall be deemed to have read and examined carefully all the Contract Documents, to have visited Site and to have taken any action necessary to fully inform themselves regarding the full requirements for the proper working of the installation, whether specifically mentioned in the Contract Documents or not.

The whole of the works specified shall be carried out to the highest standards of good practice and workmanship. Where the actual manufacturer of any equipment or accessory is not specifically mentioned, it is intended that only equipment of the highest quality be used.

.12 SUPERVISION OF WORKS

The Mechanical Contractor shall ensure that the works are, from start to finish, under the direct supervision of a competent Supervisor, Foreman or Charge-hand, and the Services Consultant shall have the right to require the withdrawal from Site of any such persons whose general conduct or handling of the job is, in their option, not satisfactory.

.13 MATERIALS

All materials and equipment used in the installation shall be new, rust and corrosion free, and of the best quality and type most suitable for the purpose specified.

The make and type of the principle items of materials and equipment are stated in the specific Clause and the Mechanical Contractor shall not deviate from the Specification without the written authority of the Services Consultant.

The dimensions of all materials and equipment supplied, and their performance and operation, shall comply with all relevant British or European Standard Specifications. Corresponding parts of similar equipment throughout the Contract shall be interchangeable.

.14 MODIFICATIONS TO THE WORKS

The Mechanical Contractor shall be solely responsible for allowing in their Contract Sum for the correct quantities of materials from measurements taken by themselves either from Drawings or wherever possible, from the Site and no variation in cost will be approved unless the works are modified. The positions of all equipment shown on the Contract Drawings may be varied by the Services Consultant before work is commenced, and the Mechanical Contractor shall carry out any modifications not involving additional labour or materials without extra charge.

No modifications to the works shall be carried out without prior written approval, and all such modifications which will increase or reduce the works shall be priced and a quotation submitted to the Services Consultant within seven days of the date of authorisation.

Upon receiving written confirmation that their tender has been accepted, the Mechanical Contractor shall within 14 days produce a detailed Schedule of Rates for the complete installation. This shall include all quantities and rates used in their tender make-up and the correct aggregate of all such quantities and rates shall equal their tender sum.

The Services Consultant may request the breakdown of the Schedule of Rates to be modified, providing that the Tender Sum is unaffected, if in their opinion, the rates are unreasonable.

Any variations to the project for items for which no agreed Schedule has been made, shall be assessed at Rates to be agreed with the Services Consultant, and these Rates shall be added to the original Schedule for future variations.

Where possible all modifications will be priced at the agreed Schedule of Rates. When required by the Services Consultant, measurements of such modifications shall be made jointly by the Mechanical Contractor and the Services Consultant and shall be to the nearest unit for which a rate is quoted in the agreed Schedule of Rates.

.15 DISCREPANCIES

Allowance shall be made for any discrepancies between the information shown on the Contract Drawings and the Specification, and the Mechanical Contractor shall be deemed to have satisfied themselves of any such discrepancy at the time of tendering.

The Mechanical Contractor shall include for all work either shown on the drawings or detailed in the Specification. No claim for extra costs can be considered for work which has only been shown on the drawings or only within the Specification and the Mechanical Contractor shall be deemed to have included for all such work in their tender price.

Should any portion of the works which would reasonably and obviously be inferred as necessary for the complete safe and satisfactory operation of the installation as a whole, not be expressly described or specified, the Mechanical Contractor shall provide and execute such works as part of the Contract and shall not yet be entitled to any extra payment on that account.

.16 ACCESSIBILITY

All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring lubrication, cleaning, adjusting or servicing of any kind. Access panels shall be provided, as specified and located on the drawings, when work is built in or concealed. If, in their opinion, insufficient access has been allowed for routine maintenance, the Mechanical Contractor shall bring this to the attention of the Services Consultant at the start of work on site.

.17 QUALITY STANDARDS

All materials and equipment furnished under the Sections of this Specification shall be new and. to the extent possible, standard products of the various manufacturers, except where special construction or performance features are called for. Where more than one of any specific item is required, all shall be of the same type and manufacture.

The Mechanical Contractor shall submit for approval satisfactory evidence of the type and quality of equipment and material they propose to use in the work. Proof of quality may be established by manufacturer's established trademarks, or by certification by the manufacturer or an approved testing laboratory of compliance with required standards, or by physical tests when so required.

.18 EQUIPMENT GUARDS

All rotating equipment including couplings, flywheels, gear trains and belt drives shall be provided with adequate guards for personal protection. Fabricated guards shall consist of flattened expanded metal mesh with an angle iron frame, small guards may be formed solid sheet metal. Guards shall be removable, and the Mechanical Contractor shall ensure that following trades do not prevent reasonable removal of equipment guards.

.19 PROTECTION OF EQUIPMENT AND WORK

Equipment openings and connections shall be provided with adequate cover at the factory to protect the equipment during transit. Such covers shall be removed by the Mechanical Contractor prior to connection of the equipment.

During the progress of the work all open ends of installed pipework and fittings shall be kept sealed off with either malleable iron plugs or plastic caps. In no circumstances shall paper or wooden plugs be used.

All plant shall be suitably protected during storage and building operations. Extreme care shall be taken to protect the building, internal partitions and floor finishes.

All damage by the Mechanical Contractor during installation shall be remedied to the satisfaction of the Architect/Services Consultant or replaced with new, the cost of this work shall be borne by the Mechanical Contractor.

.20 NAME PLATE

All proprietary equipment shall have factory applied permanent name plates indicating the manufacturer's names, model and serial numbers, temperature and pressure design, duty rating and other data necessary to conform with specified requirements, all as relevant to that item.

.21 PAINTING AND FINISHING

All purchased equipment shall have a factory applied manufacturer's standard finish of the manufacturer's standard colour, unless otherwise specified. Finishes which are marred during shipping, handling or installation shall be touched up to match the original finish. Where special colour finishes are required, the Mechanical Contractor shall notify the Services Consultant and Architect of the latest date by which they require those finishes to be confirmed.

Field fabricated bare iron or steel items required for installation of work under this section shall have rough or sharp edges removed, be thoroughly cleaned of dirt, rust, weld slag, grease and oil and be prepared and painted to an approved standard.

.22 START UP

Before starting up any system, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, correct wiring, and any other condition which may cause damage to equipment or endanger personnel. Competent Services Consultants shall be present to supervise the start-up and testing of equipment, trained in servicing the respective equipment, to the extent that the manufacturers of imported equipment shall furnish the services of their own specialist Services Consultants.

.23 SILENCE OF THE WORKS

In default of more specific requirements in the Mechanical and Electrical Services Specifications, the following shall apply to the whole or parts of the plant, equipment and apparatus.

The Mechanical Contractor shall be responsible for carrying out a full check on the schedules of silencers to ensure that the selected plant meets the noise requirements of the buildings, as detailed in the design parameters, and shall notify the Services Consultant of any potential shortcomings in designed sound levels.

The Mechanical Contractor shall check the noise ratings of all selected equipment and provide silencers with insertion losses such that the noise levels in the buildings can be met. The Mechanical Contractor's attention is drawn to the fact that the quoted noise levels and the scheduled silencer insertion losses are based on equipment selected at the period of design and the system designed as indicated on the drawings.

The Mechanical Contractor shall be responsible for the silent operation of any equipment installed by them, and shall make all necessary allowances, and provide and fix any materials required, to eliminate noise or vibration and prevent causing any annoyance to the occupants of the building, to the complete satisfaction of the Services Consultant.

All plant, equipment and apparatus or parts thereof shall be selected and installed with due care, such that it is reasonably silent in operation under all conditions under which it may have to operate, having regard to the building and works. In particular, no rattles, vibrations or discrete tones shall be noticeable in occupied areas outside the plant rooms, apparatus rooms or equipment enclosures.

Where the passage of air past, or through, components in a ductwork system regenerates noise, the Mechanical Contractor must ensure that the regenerated noise is either below the fan noise at the point, or that the noise criteria specified for the rooms which the duct system passes or in the rooms served by the duct system are met.

If, after commissioning and/or adjustment, noise criteria specified are not achieved to the approval of the Services Consultant, the Mechanical Contractor shall without extra charge, take remedial action to the approval of the Services Consultant to achieve and maintain a satisfactory degree of silence. A satisfactory degree of silence shall be judged to be that the noise is not discernible above the noise of the correct operation of plant in any occupied area.

The Services Consultant's decision as to what constitutes a satisfactory degree of silence within the terms of the Specification shall be final.

.24 TESTING

A) Mechanical

The whole of the systems shall be tested and the successful results of those tests shall be recorded on Certificates signed by the Mechanical Contractor and provided in duplicate for the Services Consultant.

Steam, LTHW Heating, HTHW Heating, chilled water, and domestic hot water supply systems shall be tested by hydraulic pressure and heat tests.

Cold water and drainage systems shall be tested by hydraulic pressure.

Ventilation and air movement systems shall be tested by operational air pressure and quality measurements.

Before any tests are carried out, 72 hours' notice of such tests shall be given to the Services Consultant in order that their representatives may be present.

Should any section of the work be tested without notice having been given to the Services Consultant, such tests shall be carried out again in their presence and if the work has been covered up it shall be uncovered at the expense of the Mechanical Contractor.

Pressure tests shall be carried out as and when required and before any thermal insulation or non-conducting composition or paint is applied.

The Mechanical Contractor shall supply all instruments to conduct the tests, and such instruments shall each have test calibration certificates establishing the accuracy of that instrument. The Mechanical Contractor shall provide all necessary test holes in ductwork etc., and for permanently sealing holes after use. 'Binder' or similar test points shall be provided on either side of each plant item, control or commissioning valve and on flow and return connections to heating and cooling coils, such that pressures and temperatures can be clearly identified at all relevant points of each system.

The Mechanical Contractor shall provide the necessary water or air pressure pumps and also the necessary plugs, blank flanges and temporary filling connections, etc., for the sealing of open ends in order that the installation may be tested in sections as required by the progress of the building operations.

All plant items on wet systems for which specific tests instructions are not given elsewhere in the contract documents, shall be isolated and tested separately by hydraulic pressure of 1.5 times the working pressure on that item.

All piping and distribution on wet systems for which specific instructions are not given elsewhere in the contract documents shall be isolated and tested separately by hydraulic pressure to 2 times the maximum working pressure on the system. All hydraulic pressure tests shall be of 60 minutes duration, during which time no loss of pressure shall occur.

Upon completion of the installation and hydraulic pressure testing of LTHW heating, HTHW heating, chilled water and domestic water supply systems the equipment shall be put into operation, the systems set to work, all valves regulated and appliances set to render the systems fully operational under design load conditions. The complete systems shall then be kept in continuous use of a minimum of two days, during which time performances tests on all items shall be carried out, as necessary, to prove the satisfaction of the design requirements, and appropriate Certificates shall be prepared by the Mechanical Contractor.

Tests shall be performed and approval of tests obtained in writing prior to backfilling, insulating, painting or concealing any pipework and/or ductwork from view.

Operational and performance tests on equipment which normally operate only during certain seasons of the year shall be made during the appropriate season where possible, and/or at such time as its ability to perform at its rated capacity can be demonstrated.

Upon completion of the installation and hydraulic pressure testing of all hot and cold water and drainage systems, the systems shall be operated at the design probable simultaneous demand

condition to demonstrate the required outflow rates and temperatures, discharge rates etc., as appropriate.

Upon completion of the installation of all ventilation and air movement systems, these systems shall be set to work and all dampers, regulations etc., adjusted to provide correct air quantities and velocities within all distribution systems. All air outlet and inlet points shall be regulated and adjusted for correct air quantities, velocities and flow patterns. If any damper cannot be adjusted due to poor installation, the grille concerned shall be modified at the Mechanical Contractor's expense until damper control can be achieved.

The correct satisfaction of the design requirements for these systems shall be recorded by certificates prepared by the Mechanical Contractor.

Should any of the systems fail to withstand tests or operate properly due to faulty materials or workmanship, the cost of any removals or reinstatement shall be borne by the Mechanical Contractor. At an appropriate date to be determined by the Services Consultant, the Mechanical Contractor's representative shall return to the site to instruct the Employer or their representative in the proper operation, regulation and maintenance of the entire installation.

B) Electrical

The whole of the electrical installation shall be tested on completion in accordance with the appropriate section of the IEE Regulations. Completion and Inspection Certificates as prescribed by the IEE Regulations shall be submitted in triplicate to the Services Consultant.

In the event that a section of the works is to be completed and operated prior to final handover, then Completion and Inspection Certificates shall be submitted for that section.

When required by the Services Consultant, tests shall be carried out in their presence.

Continuity tests shall be made during the erection of conduit and cables and finally on the complete installation. The resistance of any length of earth return path comprising cable, conduit, gland connection boxes and fittings shall not exceed the resistance of a similar length of cable sheathing or conduit.

Insulation resistance tests on PVC cables shall be made on the complete installation. The test voltage shall not be lower than 500 volts or higher than 1000 volts and the insulation resistance for a complete section connected to a fuse board shall not be lower than one megohm.

Paper insulated cables shall be tested on site in accordance with BS 6480.

Insulation resistance tests on mineral insulated cables shall be made on each length before the cores are connected, but not less than seven days after the cable ends are sealed. The test voltage shall be 1000 volts and the insulation resistance shall not be lower than 1000 megohms.

Selected seals on MICC cables shall be broken down for inspection, and provided the seals inspected are satisfactory, the number selected will not exceed one per cent of the total made.

A complete record of all continuity and insulation resistance tests shall be made and a copy kept on site. On Practical Completion a Schedule of Test Results shall be handed over to the Services Consultant.

When required by the Services Consultant, the Electrical Contractor shall prove the interchangeable of similar parts by actually interchanging the various parts.

The Electrical Contractor shall supply all equipment necessary for the carrying out of the test

without charge.

Where "connection only" of electrical equipment is specified the Electrical Contractor shall include for all tests necessary to verify that their own work is satisfactory.

.25 COMMISSIONING

The Mechanical Contractor shall demonstrate the correct operation of all parts of the systems specified herein, to the satisfaction of the Services Consultant.

The Mechanical Contractor is advised that their responsibility shall cover the commissioning of complete systems, inclusive of pipework, ductwork, packaged plant, individual plant items, controls etc. Where packaged plant forms part of the system, and such plant is "tested" at works, the Mechanical Contractor if instructed, shall ensure that the suppliers commissioning Services Consultant attends site to check out the plant when introduced into the system.

Notwithstanding, the responsibility for the work carried out by the suppliers commissioning Services Consultant shall remain the Mechanical Contractors.

Commissioning shall be carried out in accordance with recognised C.I.B.S.E. codes. The Mechanical Contractor shall, prior to the commencement of any commissioning, advise the Services Consultant in writing of the programme and method of commissioning to be adopted for their approval.

The Mechanical Contractor shall advise the Services Consultant of the need for additional pressure tapping, balancing dampers (other than those shown on the drawings), or detailed in Clause 1.24, etc., required by them to carry out full commissioning and balancing of the systems, in sufficient time such that any such provision can be made before the systems are filled, avoiding the need for draining down. The Mechanical Contractor shall be fully responsible for any failure to fully commission the system for lack of commissioning facilities.

The Mechanical Contractor shall provide attendance during the commissioning of all plant and apparatus connected under this Contract, whether or not the plant and apparatus were supplied under this Contract.

.26 RECORD DOCUMENTS

The production of all handover documents, to include Record Drawings and Operating and Maintenance manuals, will be carried out by the Mechanical Contractor. All handover documentation must be completed, approved and issued to the Client at Practical Completion of the works.

a) The Mechanical Contractor shall keep on site a complete set of drawings, and as the work proceeds, indicate on such drawings any variations in the works as executed from those shown on the Contract drawings.

b) Four weeks prior to Practical Completion of the Works the Mechanical Contractor shall provide to the Services Consultant for approval or otherwise within 14 days, a proof copy for the Operating and Maintenance Manual.

This Operating and Maintenance Manual shall include the following: -

- General description of systems, equipment and controls
- Full operating instructions for all parts of the installation
- Diagrams of main system features with all settings, calibrations etc. indicated
- Routine Maintenance Schedule with adjustments, oil and grease points and recommended lubricants shown

- Manufacturer's catalogues, specific serial numbers, rating and electrical supply of all proprietary plant and separate Service Manuals for all such plant
- Breakdown procedures
- Test and performance data of complete systems
- Copies of all Test Certificates
- Special services circuit diagram i.e. fire alarm systems etc.

c) Agreement to Practical Completion of the Contract will be subject to the Mechanical Contractor providing to the Services Consultant three copies of the approved Operating and Maintenance Manual, each bound in permanent stiff cover and having, where relevant:

- Labelled all plant valves
- Provided on site a framed diagrammatic chart referring to and explaining valve labels
- Providing to the Services Consultant a drawing showing the works as installed
- Labelled all switchgear, distribution boards and other equipment and fitted warning labels and phase indicator discs
- Provided on site adjacent to related equipment, framed circuit/distribution charts explaining distribution
- Provided to the Employer's representative, against a signed receipt, all spares called for hereinafter
- Instructed the Client's representatives in the normal operating and maintenance procedures of all plant, equipment and systems.

As installed drawings shall be prepared on completion of the works. Three prints of the drawings shall be handed over to the Services Consultant upon completion of the Contract for forwarding to the Client.

The record drawings of all underground cables shall give a complete description of the cables, the name of the manufacturer, number and cross-sectional area of conductors and date laid, the total route length and exact position of all cable joints and earthing plates.

A diagram shall be provided adjacent to each main switchboard or fuse board showing the details and functions of each switch, size and number of cores of all outgoing cables, location size and rating of all distribution boards fed from that switchboard and the phase of each outgoing circuit.

These diagrams shall not be less than 450mm x 300mm and shall be mounted in a glazed hardwood frame of approved design. The layout and wording shall be approved by the Services Consultant before erection.

The Mechanical Contractor shall also provide a complete set of CAD record drawings showing all pipe runs, plant, valves etc. as installed. The drawings shall be suitable for importing to AutoCAD Release 14 software and be in .dwg or .dfx format.

.27 POSITION OF ELECTRICAL PLANT AND APPARATUS

Unless otherwise indicated on the drawings, the routes of cables and the positions of electrical apparatus such as distribution boards, lighting points, socket outlets, switches etc., are approximate and their exact positions shall be determined on site by the Services Consultant, in consultation with the Electrical Contractor. The positions of socket outlets and lighting points and switches shown on the drawings shall be assumed to be correct for the purpose of tendering, but they may be reasonably varied without extra costs unless alterations are made after the conduits/cables are in position. The Mechanical Contractor shall ascertain on site that their work will not foul other services or furniture. Any work which has to be dismantled and reinstated due to negligence in this respect shall be their responsibility.

.28 ARRANGEMENTS OF WALL AND CEILING MOUNTED EQUIPMENT

The installation shall be arranged to secure the maximum accessibility of all parts for connecting up, inspecting, cleaning, and maintaining. Particular care shall be taken to obtain uniform and tidy arrangements of wall and ceiling-mounted equipment. The precise positions of equipment shall be determined as follows: -

(i) Single items of equipment which are visually remote from other electrical and mechanical equipment shall be positioned at the mounting heights stated in the General Specification or on the drawings.

(ii) Two or more items of equipment, whether electrical or mechanical, or both, which are to be erected on the same wall or ceiling, or which will be otherwise visually close to each other, shall be arranged in a neat and symmetrical group.

(iii) Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines of the equipment and for this purpose the mounting heights stated in the General Specification or on the drawings may be slightly varied.

(iv) The routes of all surface runs of conduits, cables and trunking shall be approved by the Services Consultant before installation.

.29 FROST BURSTS

The Mechanical Contractor will be held responsible, until they have received the Certificates of Completion, for any damage to the works, buildings and the contents thereof, due to frost burst in the works.

.30 INTERFERENCE

The Electrical Contractor shall provide and install all necessary equipment to prevent interference to radio, television and telephone by the electrical plant and equipment included in this Contract.

.31 FUEL AND WATER

Water, fuel and electricity for testing shall be provided by the Employer.

.32 PRESSURES

All pressures referred to in this Specification shall be gauge pressure, unless otherwise stated.

.33 DEFECT LIABILITY PERIOD AND MAINTENANCE COVER

12 MONTH DEFECT LIABILITY PERIOD

The Mechanical Contractor shall at their own expense make good any defects due to faulty materials or workmanship which may appear during the progress of the work and during a period of 12 calendar months after the installation has been handed over.

2 YEAR MAINTENANCE PERIOD

The Mechanical Contractor is to allow within the Tender return for providing Full Maintenance on all services for a period of 2 years from the point of Handover, the cost of consumables are not included and the cost of any parts/spares during the first 12 months is to be covered by the Mechanical Contractor, the following 12 months the Mechanical Contractor is to provide quotes and invoices for any consumables/spares parts including labour etc to the client, the client is to be given the opportunity to seek separate prices should they wish for any works identified by the Mechanical Contractor. At the end of the 2-year period the Mechanical Contractor may apply to retain the maintenance contract although the client does not necessarily have to accept.

3. STANDARD SPECIFICATION FOR MATERIALS AND WORKMANSHIP

The requirements indicated in the following clauses shall apply unless specifically indicated otherwise in Section 4 and subsequent Sections of this Specification.

.01 PIPEWORK

The installation shall be formed from tubing of the following types and qualities:

a. Mild steel black and galvanised:
Heavy weight quality BS 1387

b. Copper:
Copper tube to EN 1057:1996 Black label.

c. Polyethylene:
Blue polyethylene to BS 6572.
Yellow polyethylene to BS5556

d. PVC:
Unplasticised PVC to BS 3505: 1986 with solvent welded joints.

e. Cast Iron:
Ductile Iron to BS 6087

All pipe fittings, valves, equipment and accessories shall have factory applied markings, stampings or nameplates with sufficient data for identification to prove that they conform with specified requirements.

All necessary care shall be exercised at every stage of storage, handling, laying and erection to prevent entry of foreign matter into piping, fittings, valves equipment and accessories. No item which is unclean shall be erected or installed.

Pipelines shall run straight and true, parallel to building lines with a minimum use of offsets and couplings. Offsets shall only be provided as required to allow necessary headroom or clearance and to provide necessary flexibility in pipework lines. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. All fittings shall be off the long radius type, unless noted otherwise. Flanges or unions shall be provided and installed at all final connections to equipment, traps and valves, to facilitate dismantling. Pipe and piping connections shall be arranged so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut off valves.

All supply piping, including shut-off valves and strainers shall be installed to coils, pumps and other equipment, at line size with reduction in size being made only at inlet to control valve or pump. All pipes shall be cut to exact measurement and installed without springing or forcing. Particular care shall be taken to avoid creating, even temporarily, undue loads, forced or strains on valves, equipment or building elements with piping connection or piping supports.

Pipework shall be installed with sufficient clearance from the building structure and other services to allow easy removal and to allow sufficient clearance to other services. The Mechanical Contractor shall locate and remove any stoppage due to foreign matter or air lock which is found to impede the flow of fluid, either before or after the systems are in operation. The Mechanical Contractor shall bear the cost of making good all pipework supports, insulation, builders work, building decoration and any other damage caused in locating and rectifying such defects. (All open ends of pipework left during construction shall be covered using purpose-made caps, plugs or blank flanges.) Plugs or blank flanges to be of a design and material best suited of the size and type of pipe end. Timber, paper or rag materials shall not be permitted.

Where pipework is to be installed in floor ducts, these ducts shall be purpose made with removable covers to give access to the pipework at all times.

The pipework systems shall be installed where practical to allow thermal expansion to be accommodated by the natural flexibility of the pipework system. Pipework anchors shall be provided, with guides as shown on the drawings and as necessary to control pipe movement. Unless otherwise specified or detailed on the drawings, or as required by the written approval of the Services Consultant, gradients of all pipes carrying liquids shall not be less than 25mm in 6.0m. Pipework should be installed with gradients to ensure efficient air removal, venting and drainage for the whole of the system and parts thereof as required to provide these facilities to the whole system. Where the pipework for the services shall be galvanised finished mild steel tube, pipework shall be fabricated using screwed connections and galvanised fittings and galvanised unions. No un-galvanised pipework or fitting shall be allowed.

Unions shall be used on all pipework up to and including 50mm nominal internal diameter. Unions shall be of galvanised malleable iron and shall have ground bronze spherical seats. Flanges shall be used on pipework of 65mm nominal internal diameter and above. Flanges shall be bolted together with hexagonal bolts and nuts. Each bolt shall have two washers and shall be cropped so that one thread only protrudes above the nut, when tightened down. Nuts, bolts and washers shall have the same finish as the flanges.

Where pipework shall be copper tube suitable for non-standard bending and off-set work, joints on pipework 54mm and under shall be made using solder ring fittings and joints on pipework 67mm and above shall be fabricated couplings, fittings and flanged joints.

.02 PIPE SLEEVES AND PLATES

Sleeves shall be provided and installed for all pipes passing through floors, walls, partitions, slabs, ground beams and foundations.

All sleeves shall be laid out sized and located such that they be set and/or installed prior to pouring concrete or when masonry is being constructed. In event of sleeves being placed after floor, wall, ground beam etc., has been constructed, the Mechanical Contractor shall submit in writing to and obtain approval from the Services Consultant on location, quantity and proposed method of core drilling and installing. Cored openings shall be clean and neat without cracking or spalling. Sleeves shall be of the same material as the pipes passing through them.

Sleeves shall be standard weight steel or copper pipe having square cut ends with anchoring lugs welded on, or fabricated from mild steel plate, rolled and butt welded, having a minimum thickness of 3mm. Horizontal sleeves through walls, ground beams, foundations and partitions shall be flush with finished wall faces. Vertical sleeves though floors shall extend 50mm above finished floor and be flush on ceiling or under side.

Sleeves shall be sized such that the gap between the internal diameter of the sleeve and the external diameter of the bare pipe (where pipe insulation is not carried through the sleeve) or the external diameter of the pipe insulation (where pipe insulation is carried through the sleeve), shall be large enough to allow adequate packing of the sleeve and/or adequate clearance to accommodate pipe movement (lateral or axial) due to thermal expansion of the pipe or movement of the building.

On all pipework passing through fire walls and floors, the annular space between the pipe and the sleeve shall be fire stopped. The material must be applied in the manner recommended by the manufacturer for each particular application, and the Mechanical Contractor shall bring to the Services Consultants attention, any situation where that procedure cannot be adopted. Pipes shall not under any circumstances be built solidly into walls or plaster. Pipe joints shall not be positioned within the thickness of the structure.

.03 DRAINING AND VENTING

Unless otherwise indicated on the drawings, all horizontal water, compressed air, steam and condensate lines, including run-outs and branches, shall pitch or slope to low points to provide for complete drainage, removal of condensate and allow for venting. Pitch, unless otherwise indicated, shall not be less than 1 in 500. Accurate grades shall be maintained where lines are pitched or sloped for venting or drainage. No lines shall have pockets due to changes in elevation, unless indicated on the drawings, and only then with proper provisions for draining and venting.

Gland cocks shall be fitted with hose thread adapter at all low points of piping systems or where indicated on drawings to permit complete or sectionalised draining.

Drain pipework shall be provided from pumps, cooling coil drain trays, drip glands etc., and taken to the nearest gully as specified herein or as indicated on the drawings. Drain tundishes shall be provided at each drain boss of the item or equipment. Each drainpipe shall not be less 22mm or as indicated on the drawings. All necessary rodding points shall be provided in the drain pipework for maintenance and removal of stoppages.

At all high points and wherever else required in all water piping systems, provisions shall be made for the elimination of air. On Water Supply Systems all high points not vented by draw-offs shall be provided with air bottles and vent lines carried to an acceptable position. Air bottles shall be 200mm long and be of line size diameter on 80mm lines and above up to a maximum of 150mm diameter. On lines 50mm and below, air bottles shall be 50mm diameter. Vent lines shall be 15mm dia., complete with globe type vent valve positioned 1000mm above floor level. All vent and drain piping shall be of the same material and construction as specified for the service involved.

.04 CLEANING OF PIPING

Prior to assembly of pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice, subject to the approval of the Services Consultant. Chips and burrs from machinery of thread cutting operations shall be blown out of pipe assembly. Cutting oil shall be wiped from internal and external surfaces. During fabrication and assembly, slag and weld spatter shall be removed from both internal and external pipe joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

The Services Consultant shall be notified prior to starting any post erection cleaning operation in sufficient time to allow witnessing of the operation. The Mechanical Contractor shall consult with and obtain approval from the Services Consultant with regard to specific procedures and scheduling. It shall be the Mechanical Contractor's responsibility to arrange for proper disposal of cleaning and flushing fluids. All potable water systems shall be chlorinated as described elsewhere.

Prior to blowing or flushing erected piping systems, the Mechanical Contractor shall disconnect all instrumentation and equipment, open wide all valves, and be certain all strainers screens are removed. Following approval of flushing or blowing operations, all items disconnected or blanked off shall be reconnected, and strainer screens shall be replaced. Systems should then be prepared for testing. Any special cleaning requirements in addition to those covered in this article are indicated in the applicable sections for the service affected. Failure to obtain a contamination free system shall require repetition of cleaning. Fuel gas and medical gas pipework shall be cleaned and purged as specified by the appropriate supply authority or manufacturer.

.05 DIELECTRIC CONNECTIONS

Pipe joints connecting dissimilar metals shall be made using insulating dielectric connections. Dielectric connections shall also be provided for joining similar metals in order to isolate cathodically protected pipelines from adjoining pipe sections. Such joints, including dielectric materials, shall be rated to withstand the temperature, pressure and other characteristics of the service for which it is to be used, including testing pressure.

.06 PIPE JOINTS

Screwed Pipe Joints for steel pipework shall be made using purpose made malleable or wrought iron pipe fittings with taper pipe threads, compatible with the pipework material used. Male threads cut onto pipes for insertion into fittings shall be tapered and shall be cut with suitable pipe thread dies to match the threads on the fittings.

Flanged pipe joints shall be made using purpose made mild steel, cast iron or wrought iron screwed or welded flanges, compatible with the pipework material used. Steel flanges shall be raised face type except when bolted to flat faced cast iron flanges on equipment on which case they will be flat faced.

Joining compounds used to seal threaded pipe joints shall be non-toxic. Purpose made plastic joining ribbon tape (PTFE) may be used, alternatively linseed oil-based joining paste in association with hemp fibre may also be used. The Mechanical Contractor shall avoid the excessive use of joining material.

Gaskets for insertion between flanges shall be purpose made, full face diameter, of approved non-toxic composition material not less than 3mm thick before compression. Caulking of any joints, screwed, flanged, welded or otherwise will not be permitted.

Pipe joints on copper pipework 54mm and under shall be made using solder ring fittings incorporating tin/silver capillary solder to BS219:1977 Grade 96S, or compression type. Joints on pipework 67mm and above shall be fabricated couplings or flanged joints. Joints shall be made using water soluble flux, self-cleaning fluxes shall not be used.

Pipe joints on copper pipework 67mm and above shall be fabricated couplings, fittings and flanged joints made from non-dezincifiable metals, all with socketed ends suitable for capillary end joints feeding with silver brazed alloy. All fabricated couplings, fittings and purpose made sections of pipework to be made from tube to same specification as tube on which they are installed. Flanges and flange bolting shall be rated for maximum working pressure. Flanges shall be of the slip-on pattern for silver brazing to the pipe. Bronze welding and brazing shall not be permitted. All solder and silver brazing alloys shall be zinc free and of potable quality.

Pipe joints on non-metallic pipework shall be solvent welded, heat welded or compression type, in accordance with the manufacturer's recommendations. Only approved methods of jointing such pipework will be acceptable.

.07 HANGERS AND SUPPORTS

All piping and piping connected to equipment including valves and strainers, traps and other specialities and accessories shall be supported in a manner that will not result in or produce excessive stress, deflection, swaying, sagging or vibration in the piping or in the building structure either during erection, cleaning, testing or normal operation of the system. Piping shall not be so restrained, however, as to cause it to snake or buckle between supports or anchors to prevent proper movement due to expansion and contraction. Piping shall be supported at equipment such that equipment can be disconnected and removed without further supporting the piping. Piping shall not introduce any strains or distortion to the connected equipment.

Where building structural steel is to be fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Hangers and supports shall be provided and installed complete, including lock nuts, clamps, rods, bolts, couplings, swivels, inserts and the required accessory items. Hangers for horizontal piping shall have adequate means of vertical adjustment for proper alignment of pipe and shall be provided with lock nuts. All hangers and supports in direct contact with copper tubing shall be of non-ferrous construction or plastic coated. One piece 'snap-in' plastic pipe clips for copper tubing will not be permitted. Pipe support brackets and clips shall be designed with sufficient clearance or flexibility to prevent binding and undesirable forces being applied to the building structure, the supports, the pipework system or the

appliances to which pipework connects. Pipes shall be supported individually unless shown otherwise on the drawings.

Hangers rods for single and double rod hangers shall conform to the following: -

Pipe Size mm	Hanger Road Diameter mm
50 and smaller	6
80	10
100	12
150	16
200 to 450	20

It shall be the responsibility of the Mechanical Contractor to co-ordinate the location and method of support of the piping systems with that of all installations under other sections of this Specification. The loading of any hanger or support shall in no case exceed the manufacturer's recommended load. Hangers for insulated pipework shall be sized for the O/D of the insulation or the insulation protection saddle. On insulated chilled water piping of all sizes, the Mechanical Contractor shall provide at each support point an insulation protection shield unit consisting of a semi-cylindrical segment of high density pre-compressed fibreglass, or similar approved heavy density insulation.

Unless otherwise indicated on the drawings, the maximum spacing of piping supports for steel and copper piping shall be as follows: -

Pipework Type	Nominal Pipe Size (mm) Dia	Horizontal Support Spacing (Metres)	Vertical Support Spacing (Metres)
Mild Steel	15	2.0	2.5
	20	2.4	2.8
	25	2.7	3.0
	32	2.7	3.0
	40	3.0	3.6
	50	3.4	3.8
	65	3.7	4.0
	80	3.7	4.3
	100	4.0	4.6
	150	4.2	4.6
	200	5.1	6.0
	250	5.8	7.0
	300	6.1	8

Pipework Type	Nominal Pipe Size (mm) Dia	Horizontal Support Spacing (Metres)	Vertical Support Spacing (Metres)
Copper	15	1.00	1.25
	22	1.25	1.50
	28	1.50	2.00
	35	1.50	2.00
	42	2.00	2.25
	54	2.25	2.75
	67	2.50	2.75
	76	2.50	2.75
	108	2.75	3.00
	154	3.00	3.50

Plastic, PVC or polyethylene pipework shall be supported at centres, in accordance with the manufacturer's recommendations.

All vertical cast iron pipework shall be supported by means of galvanised steel fixing brackets with adjustable alignment, and all horizontal cast iron pipework shall be supported by means of galvanised steel hanging brackets, to suit M8 fixing bolt/rod (50mm-150mm dia.) or M12 fixing bolt/rod(200mm-300mm), all supported on short section of mild steel channel, secured by means of "Unistrut" fixings or equivalent.

.08 EXPANSION, ANCHORING, GUIDING AND THRUSTING

Expansion joints for heating and chilled water pipes shall be fully articulated twin bellows type formed from heavy wall chrome-molysteel, suitable for the working pressures of the systems. Each expansion joint shall be complete with ball ended tie bars to restrain the length of the unit and to allow offset movements in all directions at right angles to its axis. Each expansion joint shall be flanged at both ends

Pipeline anchors and alignment guides shall be provided and installed as shown on the drawings or where appropriate. Pipe expansion loops and offsets shall be provided and installed as indicated on the drawings. Expansion loops shall be cold sprung at erection. Cold springing shall be equal to 50% of the anticipated thermal expansion of the pipeline.

Concrete thrust blocks shall be provided for all underground pressure piping systems, having push-on or mechanical joints, at each change of direction horizontally or vertically. Thrust blocks shall bear against undisturbed earth. Pipework elsewhere shall generally be installed to take advantage of the inherent flexibility of bends and shall be supported in a manner to allow free expansion without undue stress on pipework branches and equipment.

.09 BRANCH CONNECTIONS

Branch connections shall be made with standard tee fittings and 45% laterals of the type required for the services.

At the option of the Mechanical Contractor, branch connection from headers and mains may be cut-in to black steel piping using forged weld-on fittings.

Use of forged weld-on fittings shall be limited as follows: -

a) They must have at least the same rating as the main.
b) The header or main must be 80mm or over.
c) The branch line is at least two pipe sizes under header or main size.

.10 TESTING AND BALANCING OF PIPEWORK

All tests shall be performed in the presence of the Services Consultant or such other parties as may have adequate jurisdiction. All defective work shall be promptly repaired or replaced and tests repeated until approved by the Services Consultant. Any damage resulting from the tests shall be repaired and/or damage material replaced, all to the satisfaction of the Services Consultant at no cost to the Client. The Services Consultant and all others having legal jurisdiction shall be notified in sufficient time to allow witnessing when a test is to be performed.

Tests shall be performed, and approval of tests obtained, in writing prior to backfilling, insulating, painting or concealing in any manner, and in accordance with Clause 2.24.

Records shall be prepared and retained for each system or section of system tested. Test reports shall be signed as approved by the Services Consultant and transmitted to the Services Consultant. If additional copies are required by those persons having legal jurisdiction, the Mechanical Contractor shall furnish them.

Test reports shall include, but not necessary be limited to the following: -

a) Identification of piping system or section tested
b) Date of test and date of Services Consultants approval signature
c) Testing medium, test equipment description (sketch if necessary), and method of description of test procedure
d) Test procedure, duration of test and recorded pressure drop.

Tests shall be observed after the pipe and contents have stabilised at the ambient temperature and the source of test pressure shut off. Pressure tests in general shall apply to piping only with all equipment, traps, relief valves and instruments blocked off or disconnected. In no case shall piping or any component be subjected to pressures exceeding their rating.

All system valves within the section being tested shall be open. Temporary restraints shall be provided on expansion joints and flexible connections during pressure testing.

Unless otherwise indicated, the hydrostatic testing medium shall be water and pneumatic testing medium shall be compressed air. Gauges used for pressure testing shall be checked and calibrated against a dead weight tester at least once per month and certified correct over the range of the gauge, to the Services Consultant. Gauges used for testing shall have minimum dial diameter of 150mm with scale divisions equal to no less than the maximum allowable pressure drop.

Service	**Normal Working Pressure (Bars)**	**Hydrostatic Test Pressure (Bars)**	**Pneumatic Test Pressure (Bars)**	**Max Pressure Drop (Bars)**	**Min Time (Hr)**
Water (Hot, cold, treated)	up to 8.0	12.0		0.14	1
Chilled Water	up to 7.0	10.5		0.14	1
Cooling Water	up to 7.0	10.5		0.14	1
Steam	up to 10.0	15.0		0.20	1
Condensate	up to 10.0	15.0		0.14	1
Low Pressure Hot water	up to 6.0	9.0		0.14	1
High Pressure Hot water	up to 14.0	21.0		0.20	2

After cleaning and testing, all open pipework and valves shall be capped or plugged with purpose-made polythene closures, unless otherwise specified. Fuel gas and medical gas pipework shall be tested as specified under the relevant sections.

All systems shall be balanced and regulated in accordance with the requirements of CIBSE Code W after hydraulic tests have been successfully complete. Proportional balancing shall be strictly followed, and on completion, all valve settings shall be marked on the commissioning drawings. Commissioning sheets shall be provided for each service with a schematic drawing showing the location of all valves, their design and actual flow rate and any marking or set point of the commissioning valve. Where low flow rates occur, the Mechanical Contractor shall use appropriate control valves to ensure that accurate balancing can be achieved. Test sheets shall form part of the commissioning data in the handover manual.

.11 STERILISATION

After successful hydraulic testing, potable water lines shall be sterilised before connecting permanently to the source of potable water. Before commencing to sterilise a pipeline, the Local Water Undertaking shall be notified so that they may satisfy themselves that there is no possibility of polluting their supply mains.

The pipelines shall be sterilised by introducing water with a chlorine dose of at least 10 ppm (10 mg/L). After standing for 24 hours, the water shall be tested for residual chlorine to ensure that satisfactory sterilisation has been achieved. Potable water may be used to displace the chlorinated water, but the pipeline will not be put into service until bacteriological tests of water delivered at the end of the pipeline show that a satisfactory potable standard has been achieved. The Mechanical Contractor shall produce a certificate from a reputable body confirming satisfactory chlorination for each section of Potable water pipework tested.

.12 PAINTING

Decorative painting to pipework, fittings, equipment and associated steelwork, including insulated pipework, fittings and visual equipment and the plant areas in the buildings, shall be carried out under the Architect's direction by the Main Mechanical Contractor.

Decorative painting to un-insulated pipework, fittings, equipment and associated steelwork on roofs of the buildings shall be carried out under the Architect's direction. Weatherproof insulated pipework fittings and equipment on the roofs of buildings shall receive no further finish.

Prior to applying the decorative finish to exposed pipework and supports, the surface shall be corrosion protected.

Equipment in plant areas which have factory applied decorative paint finish will have no additional painting.

No painting will be carried out until hydraulic testing has been certified satisfactory.

.13 IDENTIFICATION

All insulated and un-insulated pipework in plant areas, service voids, service ducts, false ceilings and exposed in corridors and the roofs shall be provided with colour coded bands to indicate the service, together with direction arrows to indicate direction of flow and an F (flow) or R (return) where appropriate.

Identification colour coded bands shall be to International Pipework Colour Coding Standards and may take the form of self-adhesive plastic tapes. Identification will be applied after completion of painting specified elsewhere in this Specification to BS 1710 and BS 4800.

.14 LABELLING

All items of plant and equipment shall be clearly identified by means of engraved ivorine labels securely fixed or attached to the wall in a position clearly visible.

All manual and automatic valves and pump strainers shall be identified with a valve number related to the valve schedule forming part of the Operating and Maintenance Manuals.

The Mechanical Contractor shall provide these labels and each label tag shall be sized to contain 15mm high lettering. The engraving shall be in white on black laminated material. The labels shall be secured in an easy position on the valve stem, handwheels, or in a hole drilled in the lock shield, with a key ring such that the valve operations are unaffected. Whenever this is not possible due to the design or type of valve the label shall be fixed with a brass chain around the body of the valve.

Valves, stop cocks, drain cocks, air cocks and other similar items requiring periodic inspection, operation and servicing, but located in cupboards capable of being locked, shall have labels fixed by the Mechanical Contractor to the outside of the cupboard doors indicating the presence of valves etc. within the cupboard.

Where valves, stopcocks, draincocks etc. are located above suspended ceilings or in floor voids the Mechanical Contractor shall ensure that suitable identification discs are fixed to the removable ceiling tile immediately below the valve or the floor access panel immediately above the valve.

.15 VALVES

Valves as specified herein and shown on the drawings, or as required, shall be provided and installed to ensure that all plant items, control and commissioning valves and branch circuits can be isolated and regulated. Where possible, all valves shall be of a single manufacturer. Valves shall conform to specifications for the specified service. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to the recommendations of the valve manufacturer for the intended service. If space permits, valves shall be installed with stems horizontal or extending vertically upwards unless specifically shown otherwise. All valves shall be installed in accessible locations for operation as well as removal, repair or replacement.

Shut-off valves shall be provided and installed in both flow and return lines at each item of equipment. Valves and cocks size 50mm nominal bore and below shall have screwed ends with taper heads. All valves 65mm nominal bore and above shall have flanged ends. All draw-off points or ranges of draw-off points shall be provided with lock shield isolating valves. Valves not enclosed in false ceilings, service shafts, ducts and plant rooms shall be provided with lock shield operation or will have the hand wheels removed and handed to the Client, to prevent unauthorised operation.

.01 Valves for Hot and Cold Water Systems (Chilled Water and LPHW HTG Systems)

All isolating valves in pipework up to and including 50mm nominal bore shall be gunmetal or DZR ball type valves with lever/lock shield as indicated elsewhere in the Specification. These shall be as Crane Ltd Fig. D171or Oventrop Ltd Fig. 107 70.

All isolating valves in pipework of 65mm nominal bore and above shall be cast iron gate valves, with wedge disc. The valves shall have rising stems outside screw and yoke, bolted bonnet, replaceable gland packing, bronze trim and hand wheels. These shall be Crane Ltd Fig. F52 or Oventrop Ltd Fig 104 51.

All steam valves shall be of the bronze globe type with non-rising stems, and shall be as Crane Ltd Fig. D5.

.02 Radiator Valves

Radiator valves shall be bronze globe style angle valves, with screwed female taper thread end to pipeline and screwed male taper thread union end for insertion into the radiator tapping. Radiator valves shall be of an easy clean design with polished bodies and plastic handwheels or lock shield. Valves or radiator flow connections shall have wheel operation. Valves on radiator return connection shall have lock shield operation. These shall be Hertz Dr-T-90.

Where called for, radiators shall be provided with thermostatic radiator valves on the flow connection to replace the wheel valve. These shall have integral or remote sensors as specified and be installed in accordance with the manufacturer's recommendations. These shall be Hertz type TS-90.

.03 Valves for fan coil units

In addition to the thermostatic control valves specified elsewhere, all fan coil units shall be provided with lever operated line size ball valves for plant isolation. These shall be Hertz type 4116 or Oventrop Fig. 107 60.

.04 Valves for Gas Systems

The fuel gas systems shall be provided with isolating valves and cocks, as shown on the drawings, to sectionalise the systems. Valves and cocks shall be lubricated parallel plug valves with cast iron bodies with wrench operation, and with suitable sealing compound.

.05 Non-Return Valves for Hot and Cold Water Services and LPHW and Chilled Water

All non-return valves in pipework up to and including 50mm nominal bore shall be bronze swing check valves with metal to metal seats and screwed bonnet.

These shall be Crane Ltd Fig. D140 or Oventrop Fig. 107 50.

Non-return valves 65mm nominal bore and above shall be cast iron swing check valves with rubber faced gunmetal disk, bolted cover and all iron trim.

These shall be Crane Ltd Fig. FM469.

.06 Double Regulation Valves for Hot and CWS LPHW HPHW and Chilled Water

Double regulation valves in pipework up to and including 50mm nominal bore shall be bronze globe valves with characterised disk and metal to metal seating, inside screw rising stem and screwed bonnet. Valves shall be provided with handwheels. The valves shall be provided with a device to prevent the valve being opened beyond its set regulated position. The valve shall also be capable of being used as a stop valve.

The double regulating valves shall be provided with test plug and cap assemblies on the inlet and outlet side of the valve. The test plug shall be suitable for safely attaching a pressure probe whilst the line is under pressure. Probes and test equipment compatible with the test plug shall be provided by the Mechanical Contractor for commissioning purposes. Upon final completion these shall be handed to the Client. Where low flow rates occur, the Mechanical Contractor shall install valves suitable for that purpose. Valves shall be supplied with manufacturer's flow charts indicating flow against pressure drop across the valve to enable commissioning to be carried out. Suitable valves shall be:

- Up to 50mm - Crane Ltd Fig. D930 or Oventrop Ltd Fig. 106 02
- 65mm and above - Crane Ltd Fig.DM930 or Oventrop Ltd Fig. 106 26

.07 Needle Valves for Air Release, Hot and Cold Water Service, LPHW and Chilled Water

All needle valves on pipework up to and including 50mm nominal bore shall be bronze globe valves, with metal to metal seating, inside screw, rising stem, screwed bonnet and bronze body. These shall be Crane Ltd Fig. D71.

.08 Drain Cocks

Drain/emptying shall be installed at low points and on the dead side of all main isolating valves, and where indicated on the drawings. Drain cocks shall be bronze draw-off cocks with lever operation. In plant rooms they shall be straight type, Crane Ltd Fig. D171HU or Oventrop Ltd Fig. 1033 33 pattern, detachable hose union. Where exposed to view in rooms they shall be Crane Ltd Fig. D340 or Ballofix Ltd Fig. 25095B1.

Drain cocks shall be sized to the following requirements:

- 15mm for draining pipes up to 25mm nominal bore
- 20mm for draining pipes 32mm to 80mm nominal bore
- 25mm for draining pipes 100mm to 200mm nominal bore
- 40mm for draining pipes 250mm nominal bore and above.

.09 Stopcocks for Hot and Cold Water Services

Stopcocks shall be provided and installed on pipes up to and including 50mm nominal bore. Stopcocks shall be double union bronze type, with screwed bonnet and gland. Discs shall be composition faced. Gland packing shall be replaceable. Stopcocks shall be as Yorkshire 508GM.

.10 Three-Way Cocks for Combined Vents

Where open vents are combined from two or more plant items operating in parallel, they shall feed into a common open vent pipe utilising three-way vent cocks, suitable for the pressure and temperature of the system.

Three-way vent cocks of nominal bore up to and including 50mm shall have screwed bronze bodies, taper ground plug and bolted gland. The valves shall be as Nabic Ltd Fig. 175.

Discharge pipes from 3 way cocks shall be run to a safe position, preferably to discharge over a gully or tundish.

.16 STRAINERS

Strainers shall be installed as specified herein and as shown on the drawings. Whether detailed on the drawings or not, unless otherwise stated, the Mechanical Contractor shall ensure that at least one full bore line strainer is fitted to every heating and chilled water system. The Mechanical Contractor shall submit for approval by the Services Consultant a schedule of all strainers indicating the service, size and connections, screen material perforation, size of mesh, make, model number and any special features such as blow down cock. As nearly as possible all strainers shall be of a single manufacturer. All strainers shall be suitable for the pressures and temperatures of the systems in which they are installed and shall have local isolating valves for removal of the screen without draining down the whole installation.

Strainers shall conform to the following specifications. All gaskets, screens, meshes, etc. shall conform to the recommendations of the strainer manufacturer for the intended service. The following specification shall apply to strainers for the relevant services.

A) Pipework services (excluding gas services) up to and including 50mm nominal bore, screwed 'Y' type bronze or pressed brass constructions with screwed covers for removal of strainer basket for cleaning. As Crane Ltd Fig. D297 or Oventrop Ltd Fig. 112 00 B) Strainers above 50mm shall be cast iron with bolted cover for removal of strainer basket. As Crane Ltd Fig. FM276 or Oventrop Ltd Fig. 112 20.

Unless otherwise indicated on the drawings or specified, pipeline strainers shall be 'Y' pattern and shall have stainless steel screens or meshes as follows:

- Steam and air - 0.8mm diameter holes
- Water - 1.6mm diameter holes

All strainers shall be installed in accessible positions for cleaning purposes as well as for removal, repair or replacement.

Strainer baskets shall be positioned as follows:

- Steam and air - basket horizontal to one side of pipeline
- All liquids - basket vertically below pipeline

Pipe nipples and globe valve shall be provided and installed where necessary for blowing down strainer screens.

.17 THERMAL INSULATION

All hot and cold water services pipework shall be insulated where hidden from view in service ducts, plant rooms, floor voids, etc. Any pipework on view in public areas shall not be insulated, unless otherwise stated. Insulation shall be applied in a neat workmanlike manner with all joints taped and sealed to Class 'O'.

All heating, hot water service, cold water, chiller water, steam and condense pipework shall be insulated as detailed within this specification, or as otherwise called for, as well as all supply and recirculation ductwork. Vapour seals shall be provided where condensation is likely to occur, and the manufacturer's instructions for installation, with regard to jointing, sealing, pipe supports, and finishes shall be strictly observed. The same material shall be used for all services on any project, and only the thicknesses, configuration, and finish of the material shall vary on the different services.

All thermal insulation shall comply with the requirements of BS5422 and 5970. All materials shall be suitable for the temperature and condition of the service and environment for which they are specified and shall be proof against rotting, mould, vermin and fungal growth.

All materials shall be non-combustible in accordance with BS476 Part 4, and shall have a surface spread of flame to Class 1 in accordance with Part 7 of BS 476 where they are not encased in sealed fire zone, and Class O where they are encased in sealed fire zones.

Thickness of insulation shall be as shown in the tables in this specification.

All thermal insulation, unless indicated otherwise in the following Sections of this Specification, shall be Armaflex AF/Armaflex closed cell CFC free elastomeric material generally, and Class "O" Armaflex where this is required.

Thermal insulation shall be continuous with outer coverings continuous through support joints.

Valve bodies shall be insulated with purpose made valve boxes manufactured from Armaflex sheet in accordance with the manufacturer's instructions.

Insulation in service ducts, false ceilings and other areas concealed from view shall be self-finished, with care being taken on cold services to maintain a continuous vapour seal.

Ductwork shall be insulated with AF/Armaflex flexible sheet fixed in accordance with the manufacturer's instructions.

Unless otherwise agreed, insulation in plant rooms and boiler houses shall be finished with hammer clad aluminium sheeting, with thicknesses of aluminium to be not less than 0.7mm on pipework up to 150mm, and not less than 0.9mm on pipework up to 450mm diameter. Overlap on all joints shall not be less than 40mm, and heat bridges between hot pipework surfaces and cladding is unacceptable.

External pipework and ductwork insulation shall be painted with Armafinish HN paint to ensure weather protection. This shall be applied in accordance with the manufacturer's instructions 48 hours after the adhesive has set. A second coat shall be applied 24 hours after the first coat to achieve the desired protection.

The final colour of all paint shall be to the Architect's approval.

All thermal insulation shall be applied by an installer who has received an approved training certificate from the manufacturer, and a copy of this approved certificate shall be supplied to the Services Consultant before installation commences. Great care shall be taken to achieve the best finish possible and consistency in joints in all areas.

Armaflex insulated pipe supports shall be used on all chilled water pipework to prevent cold bridging.

All pipework shall be identified with self-adhesive colour bands to BS1710, with direction of flow arrows.

Thickness of Insulation

Nominal Bore	Thickness
15mm	19mm
20mm	19mm
25mm-40mm	22mm
50mm-150mm	32mm
150mm-300mm	32mm
Flat surfaces	32mm sheet

.18 THERMOMETERS

Thermometers of Brannen Ltd manufacture or approved equal shall be provided and installed at locations indicated on the drawings and as specified. Thermometers shall be located such that they can be easily read from floor level or operating platform.

Wells and sensing elements shall be located and arranged such that the sensing elements are in the path of the moving fluid and not positioned in stagnant or dead end locations. Wells shall not obstruct the flow of the fluid being measured. Pipes 25mm and smaller shall be increased by one pipe size at the point of insertion. Extension necks shall be provided on thermometers directly mounted on insulated piping, vessels and equipment.

If the temperature sensing element location is 2500mm or more above floor level, a remote bulb type shall be provided with the dial located at eye level mounted on the building structure or a nearby partition with the nameplate to indicate the service being monitored. Remote bulbs shall have armoured capillary of required length. Capillary shall be ambient temperature compensated as required to maintain specified accuracy at all ambient extremes. Accuracy shall be ± 1% or better of scale range. Thermometer scale ranges and scale diversions in degrees C shall be as indicated below.

Unless otherwise indicated or specified all thermometers shall be 100mm diameter dial type if remote bulb mounted type. Thermometers shall have brass or stainless steel movements, white face with black scale marking, mercury filled system and with copper or brass bulbs. Dial type thermometers shall have adjustment provision for calibration without removing pointer. Dial thermometers shall be fitted with ambient temperature compensated cases and movable red pointers initially set at normal operating temperature of the service.

Thermometer Schedule

Service	Range °C	Max Div
Cold Water Service	-10 to 60	0.5
Hot Water Service	0 to 120	1.0
Chilled Water	0 to 20	0.5
Cooling Water	0 to 100	1.0
Condensate 0 to 150	1.0	
Boiler Feed Water	0 to 150	1.0
High Pressure Hot Water	0 to 180	1.0
Low Pressure Hot Water	0 to 120	1.0

.19 PRESSURE GAUGES

Pressure gauges of Brannen Ltd manufacture or approved equal shall be provided and installed at locations indicated on the drawings and as specified. Pressure gauges shall be located such that they can be easily read from floor level or operating platforms.

An altitude gauge shall be provided for each boiler or range of boilers in an open system to indicate the system static pressure.

Pressure gauges installed on piping shall be located in straight runs of pipe and shall each be provided with a gauge cock in the sensing line. Combined vacuum and pressure gauges shall be provided where normal operating pressure is at or near atmospheric pressure. Pressure sensing taps shall be located and installed so as to accurately sense fluid or gas pressure.

Extension necks shall be provided and installed for pressure taps in insulated piping, vessels and equipment. Gauge cocks shall be PTFE packed and constructed so that it is impossible for the plug to be blown out of the body of the cock, with gland leakage entirely eliminated.

If the pressure sensing point location precludes easy reading due to dial size specified, the Mechanical Contractor shall furnish a gauge of sufficient size such that it can be easily read. Scale divisions for all pressure gauges shall be a maximum of 5.0 kPa for ranges up to 400 kPa, and a maximum of 10 kPa for ranges of 800 kPa, and50.0 kPa for ranges of 2000 kPa and over. Accuracy shall be ± 1% or better of scale range for middle half of scale and ± 1½% or better for remainder of scale.

Scale ranges shall be selected such that normal pressure condition shall fall approximately at mid-scale. Scale ranges shall be wide enough to cover all expected extremes but should not exceed more than 100 kPa beyond those extremes. Pulsation dampers shall be provided on all gauges installed on discharges of pumps.

All pressure Gauges shall be installed with syphons and gauge cocks. Pressure gauges on steam lines shall be pigtail type syphons. Pressure gauges on other services shall have 'U' type syphons.

Unless otherwise indicated or specified, all pressure gauges shall be Bourdon tube with minimum 100mm diameter dial, aluminium case, white face with black scale markings, brass or stainless steel bushed movement, phosphor tube and brass or stainless steel socket.

Units shall have adjustment provisions for calibration without removing or bending pointer. A movable red pointer shall be incorporated to indicate normal operating pressure of the service being monitored. In addition, a distinctive permanent red line shall be provided at the maximum permissible working pressure.

.20 NAME PLATES

All plant and apparatus shall be provided with name plates bearing the maker's name, reference number, size, type, test and working pressures, speed and any other relevant particulars engraved thereon.

.21 MAINTENANCE TOOLS

The Mechanical Contractor shall not be required to provide any maintenance tools, unless specifically requested elsewhere in this specification.

.22 DUCTWORK

The system of ductwork used throughout this project shall be manufactured in accordance with DW144, or as detailed hereinafter, and be generally as shown on the Contract drawings. The Mechanical Contractor shall be deemed to have allowed for all supports, fixings, joints, shoes, test facilities, jointing compound and all other items not specifically mentioned, to ensure that the installation is complete. Where bends are of a mitred right angle configuration they shall have suitable turning vanes.

The Mechanical Contractor shall provide access doors upstream of all opposed blade volume control dampers, and dampers shall be provided on all branches serving three or more outlets. Test holes shall be drilled on site where necessary to regulate and balance the installation and shall be sealed with suitable rubber inserts on completion. All ductwork shall be tested on completion and test figures submitted to the Services Consultant for approval. After the installation has been tested, thermal insulation may be applied as specified elsewhere.

Duct, plenum and casing sizes shown on the drawings, unless specifically indicated otherwise, are clear inside opening dimensions. Where internal lining is indicated on the drawings or specified, the sheet metal duct, casing or plenum shall be increased by an amount equal to the aggregate thickness of the lining. Materials and equipment furnished and/or installed under the work of this section of the Specification shall be stored, handled, installed, tested and put in operation in strict accordance with the manufacturer's recommendations and as specified.

Construct ductwork, casing and plenum joints square, with all sharp edges and protrusions removed. Support and brace ductwork casings and plenums rigid to prevent vibration. Except as specifically shown on drawings or specified herein, piping, electrical conduit, building elements, etc. shall not come into contact with or pass through ducts or casings. Route ductwork directly avoiding all unnecessary directional changes and abrupt transitions. Install plenums, ducts, casings and hangers straight, plumb and level.

Provide adequate space around ducts to assure proper support and to allow for installation of insulation. Ducts passing through floors, walls etc. which do not require fire dampers shall have clearance space sealed airtight. Seal clearance space by tightly packing with mineral fibre insulation. On vertical duct penetrations where no curbs are provided, flash duct to floor.

Radiused elbows shall have a minimum centre-line radius in accordance with Fig. 87 in turning plane for rectangular ducts and 1.0 times diameter for round ducts. Square throat or mitre elbows shall be made using double skin aerofoil type turning vanes as specified herein and indicated in Fig. 30b.

Sheet metal ductwork shall be manufactured from galvanised sheet having thickness and properties as indicated in Table 2. Reinforcing, bracing, supports, tie rods, rivets, screws, bolts, nuts and accessories used in direct contact with ductwork and casings shall be of materials identical to the duct materials unless indicated otherwise.

All openings in casings and ductwork shall be sealed, including air inlets and outlets during construction with plastic, canvas or timber to prevent entry of dirt and other foreign materials.

Prior to operating fans, all foreign material shall be removed and interiors of casings including coils, fans and dampers shall be cleaned. Fans shall only be operated when filters are in place and operating. Store and handle fabricated duct sections prior to and during erection such as to prevent exposure to weather, dirt and physical damage. Clean dirt from interiors of ductwork at time of erection. Upon successful completion of tests, replace all used filter media.

Provide and install hangers and supports to carry the weight of ductwork, including equipment within or attached thereto such as coils, humidifiers, filters, dampers, attenuators, etc. without incurring vibration, sagging, bending, twisting or buckling or other deformation in the ductwork or building structure either during erection, testing or normal operation. Sheet metal ductwork supports or hangers shall not be used for supporting any other service. Where building structural steel is to be fireproofed all hangers, clamps etc. which attach to it shall be installed prior to application of fireproofing.

Drop rods for horizontal ductwork supports shall be fixed to inserts in the underside of floor slabs. These inserts shall be fixed in by shot firing or drilling into the pre-cast panels on site, as approved by the Structural Services Consultant.

Install hangers or supports adjacent to each duct mounted coil and at connections to equipment. All hangers, supports, clamps, angles etc. in contact with the ductwork shall be of the same material as the duct unless otherwise stated. All bolts, nuts, washers, screws and other fasteners shall be cadmium plated, stainless steel or otherwise corrosion resistant.

Unless otherwise indicated, support rectangular ductwork and associated equipment by structural steel shelf angles or welded angle frames, as detailed in Figs. 6, 69, 70.

For floor supported ductwork, use cross braced welded structural angle iron frames with each leg bearing on 200 x 200 x 6mm sole plate. Alternatively, a proprietary galvanised steel channel may be used.

Support round ductwork by formed clamps as figs. 64, 65, 66, 67.

Unless otherwise indicated, support vertical round and rectangular ductwork every 4 metres. Vertical ductwork shall be supported as indicated in Figs. 76, 77.

Circular and flat oval ducts shall be supported by means of two stirrups each welded to a main spanning support angle. Stirrups shall be bolted together to form a clamp around the ductwork.

.01 Welding

All surfaces to be jointed by welding or brazing shall be cleaned of grease, oil, dirt, oxidation or other foreign substance. Exercise care to avoid burning through sheet metal.

.02 Black and Galvanised Steel

On ductwork 1.6mm thick and heavier, use filler rods in accordance with standards for iron and steel gas welding rods. On ductwork 1.3mm thick or lighter, use filler rods in accordance with standards for brazing filler metals. After completion of welding on galvanised ducts, apply one coat of grey primer and, when dry, one coat of aluminium enamel to surfaces affected by the weld heat both inside and outside of the duct.

.03 Stainless Steel

Welding shall be by the Tungsten Inert Gas process using Argon Shielding. Procedures shall be in accordance with welding equipment manufacture. Welding rods shall be as recommended by stainless steel manufacturer.

a. Rods shall be of the same type of stainless steel and compatible with the sheets being welded.

b. Rods shall have chromium content not less than one per cent above that of the steel to offset its loss during welding.

Stainless steel ductwork which is left exposed to view within finished and occupied spaces shall have all welds ground smooth and polished to match finish on adjoining sheets. Unless otherwise indicated on the Drawings, construction shall be limited to systems or sections of systems operating at or below a mean air velocity of 10 metres/sec.

Secure transverse joints and joint reinforcing with drive screws or rivets at corners and along the joints at intervals of not more than 150mm. Joint slips shall not be less than heaviest metal gauge of the connected duct. Joint reinforcing bars and angles shall be same thickness as the corresponding transverse bracing angles.

Round ducts shall be machine fabricated spiral lock seam type. Fittings for round ductwork shall be factory fabricated with all seams and joints continuously brazed or welded. Elbows shall be press fittings, from 80mm dia. up to 315 dia. and fabricated segmented bends thereafter.

Construct slip joints between round spiral duct sections by slip fitting connecting ducts over an internal galvanised steel connector sleeve not less than 40mm long for duct sizes up through 200mm diameter and 75mm long for duct sizes 224mm up through 1250mm. Construct slip joints between round spiral duct fittings by slip fitting the duct over the fitting collar. Just prior to joining, coat mating surfaces with liquid duct sealant. After slip joining, fasten each pair of mating surfaces with drive screws at maximum intervals of 300mm around perimeter using a minimum of 4 drive screws.

Rivet manufacturer's recommendations as to use, size and drill size are to be followed. Rivets resulting in an unsealed aperture shall not be used.

Self-Tapping screws, while not recommended, are acceptable in circumstances in which the use of other fastenings is impractical.

Sealants and other materials, when used in connection with ductwork, shall permanently retain adhesion and elasticity through a temperature range of 0°C to 70°C. Gasket-sealant shall be provided in the form of pre-formed roll, sheet or strip applied between opposing faces of flanged or other joints. Gaskets should be not less than 3mm thick for rectangular ducts up to 1500mm longer side or circular ducts up to 1250mm diameter. For longer ducts, the gasket should not be less than 4mm thick.

.04 Drying and/or Curing Period

Solvent based and chemical reaction types of sealant require a period of between 24 and 72 hours for drying or curing, depending on conditions. The cure shall be completed before the duct is pressurised, to avoid rupture of the joint occurring. The use of self-adhesive tapes as a primary sealant shall not be allowed.

Galvanised sheet ductwork shall not be further treated except where the galvanised finish has been damaged or destroyed in the construction/manufacturing process. All cut edges of the galvanised sheets and any area damaged during erection shall be painted with two coats of Galvatite paint.

Ductwork stiffening shall be thoroughly wire brushed to remove any surface rust and angles and angle iron flanges painted with two coats of Galvatite paint, for protection against corrosion.

Turning vanes shall be constructed of the same material as the ducts in which they are installed and shall not be less than 0.8mm thick. They shall be double skin aerofoil vane type spaced and

dimensioned in accordance with the details in Fig.55. Vanes shall be positioned and held in the elbows with preformed guide rails or runners. The rails or runners shall be riveted, spot welded, brazed or metal screwed at a minimum interval of 150mm to the duct. The vanes shall be attached to rails or runners in the spaced guide slots by crimped lock.

.05 Flexible Ductwork

The material used for any flexible joints must meet any conditions of temperature and air pressure specified and shall comply with the standard of air tightness specified for the rest of the ductwork system of which it forms part. All final connections between duct spigots and supply air diffusers, recirculation and extract grilles located in false ceilings together with ductwork connections to items of plant may be made with flexible ducting or flexible joints, as indicated on the Drawings and as specified herein.

Flexible joints shall be fitted at inlet and outlet connections to all fans where ductwork is subject to movement or thermal expansion, or where the ductwork is subject to the effects of building expansion. Care should be taken to maintain alignment between ducts or duct and fans etc. Flexible joints shall be kept as short as practicable above a minimum effective length of 50mm.

For flexible connections, the flexible joint shall be held in place with flat bar strips. A backing plate shall be used with proprietary joints having metal edges. Backing plates shall not be less than 3mm thick. A sealant or gasket shall be used to ensure an airtight joint.

Adaptors shall be used to provide plain circular ends for spirally-wound ducts. Alternatively, flanged connections may be used. A sealant shall be used between the duct and the flexible joint, and the joint secured by clip-bands with adjustable screw or toggle fittings.

Circular flexible ductwork for connections to extract air grilles and diffusers shall be formed from aluminium strip, corrugated for additional strength. Circular flexible ductwork for connections to supply air grilles and diffusers shall be specified previously but in addition shall be factory insulated with a minimum of 25mm fibre-glass covered with a seamless polythene outer sleeve. The minimum length of flexible duct shall be used in these occasions, and all excessive coils shall be removed before testing commences.

Flat oval ductwork shall generally be installed in the same manner as rectangular ductwork, and using the standard sizes and stiffening requirements shown in DW144.

.23 MOTOR OPERATED DAMPERS

Motor operated dampers as specified herein, and where indicated on the drawings ready for final connection to motor operators, shall be of the opposed blade type. Sealing strips shall be provided at the end of damper glands. All dampers shall be fitted with neoprene or rubber edged seals to provide 100% shut off.

Dampers shall be sized as indicated on the drawings. If the damper size is not indicated, they shall be sized to match the building opening, duct or casing as required.

Maximum size of any one section shall be 1200 x 1200mm. Where a larger damper is required in either or both dimensions a separate section shall be provided.

Sections shall be jointed by bolting adjoining frames on maximum of 150mm spacings. In addition, adjacent blades top to bottom shall be linked together at a minimum of two points and a common link bracket on centre drive blade where multiple sections are required.

Dampers shall be installed with necessary closures and sealing to ensure air does not bypass the damper frame, and damper frames shall be bolted to ducts, casing or building construction at a minimum of every 150mm. An extension shaft for each damper section or assembly shall be provided

located within the duct where motor is to be mounted externally.

.24 BALANCING DAMPERS

Manually operated dampers shall be provided where indicated on the drawings and at all other locations necessary to properly accomplish the air balances. Volume dampers located in branch ducts which terminate at one or more inlets or outlets shall be located as far from the inlets or outlets as possible.

Volume dampers shall be mounted and sealed in ductwork to prevent vibrations or air leakage. Bolt frames to connecting ducts not less than every 150mm. When located in externally insulated ducts, the operating shaft and a locking type manual regulator shall be extended 400mm from side of duct and attached thereon to clear finished surface of insulation. An access door shall be provided at each volume damper. On internally insulated ductwork, size frames to match sheet metal sizes and compress thermal insulation where frame attaches.

For ductwork with a short side up to and including 250mm, dampers may have a single aerofoil blade. Dampers in ducts over 250mm high or deep shall be multiple opposed blade type, gang operated with a maximum blade depth of 250mm. Damper blades shall not be less than 1.6mm thick with hemmed interlocking edges and a maximum of 1200mm long. Each blade shall be supported on two 12mm diameter bearing pins secured with bolted bearing straps.

The operating rod shall be 12mm diameter continuous the entire length of the damper blade and extend through frame and duct to externally mounted bearing plates. The operating rod shall be attached to its blades by two bolted bearing straps each with a single bolt through the shaft, blade and strap. Provide indicating type locking regulators.

Dampers for insertion into ductwork having a longer side greater than 1500mm shall be constructed in multiple frames and contained in a separate fabricated flanged galvanised case which shall extend beyond the swing of the blades.

Each damper shall be proved with a damper quadrant regulator designed to give 90° rotational blade movement from fully open to fully closed and permit the damper blades to be fixed and locked in position after balancing.

.25 ACCESS PANELS AND DOORS

Access panels shall be installed in ductwork for access to motorised dampers, fire dampers, lubricating fittings, fans, control, duct heaters, screens and cleaning of ductwork and other equipment and accessories requiring periodic inspection or service. Totally removable access panels shall be limited in use to only where hinged doors cannot swing to 90% open position without interference. Walk-in access doors shall open or swing against pressure wherever possible.

Access panels and doors shall be fabricated, fitted and installed of the same materials and weights and to withstand the same test pressures without deformation, vibration or leakage, as the ductwork or casings in which they are provided. Access panels and doors located within insulated ductwork shall be internally reinforced, double skin panel type with interior voids completely filled with not less than 25mm thick, 96kg/m^3 density, mineral rigid fibre insulation board. Access panels and doors in un-insulated ductwork shall be reinforced, single skin type.

All access doors and panels shall be fitted to framed openings in ducts. Frames shall be all welded or brazed fabricated units consisting of minimum of 3mm thick angles or channels bolted to duct or casing on a minimum of 150mm intervals.

Frames shall provide a continuous airtight gasketted stop around the entire perimeter. Gaskets shall be a minimum of 6mm thick closed cell neoprene sponge rubber, compressed into formed recess and stuck with adhesive.

For access doors 600mm in height or less, provide two heavy duty zinc or cadmium plated steel butt hinges with brass pins and one handle through the door latch assembly.

For access doors above 850mm high provide two heavy duty zinc plated steel butt hinges with brass pins and two handle type through the door latch assembly operable from both sides of the door.

For totally removable access panels, provide four cadmium plated sash type latches and one die cast door pull all bolted through the door and frame.

.26 TEST POINTS

Test points shall be provided in ductwork up or downstream of each coil, fan, filter or volume damper, except where the damper serves a single grille or diffuser, and at other locations required to perform the air balancing. These test connections are for the purpose of taking static pressure and pitot traverse readings. Where openings are required both up and downstream of a device, one side shall have multiple openings and the other side a single opening.

All test holes in rectangular ductwork shall be 25mm diameter drilled in one side only. The side of the duct for test hole drillings shall be determined on site to facilitate easy commissioning. Polythene or rubber grommets shall be supplied to seal off the test holes.

.27 FIRE DAMPERS

Fire dampers shall be provided as specified herein and in the locations indicated on the drawings.

Fire dampers shall also be installed, whether indicated on the drawings or not, in all air ductwork passing either between occupied floors or between plant rooms and occupied floors.

Openings shall be prepared prior to masonry wall and floor construction. Openings shall be accurately sized to the dimensions of the fire damper assembly irrespective of the design duct size. Openings shall be held to a tolerance of -0mm and +25mm.

Fire dampers shall be of the following types: -

a) Block type - Steel framed intumescent paint treated honeycomb case damper; honeycomb enclosed with 25mm galvanised steel mesh on each side.

Application: Suitable for installation within fire barriers up to a maximum rating of 1 hour only and a maximum velocity of 10m/s.

Location: To be used in doors or walls behind grilles (to allow easy removal of honeycomb core by removal of grille) or in vertical or horizontal ducts. When used behind grilles, the fire block shall be held in position by either a galvanised steel angle or asbestos block retainers.

When used in ductwork, the fire block shall be housed in a metal casing, installed in the ductwork, with a removable cover to enable the honeycomb core to be removed sideways for inspection or replacement.

b) Plate type - Suitable for installation up to 4 hours (dependant on plate thickness).

Location: To be used only in ductwork systems where the block type damper cannot be used due to the higher rating of the fire barrier or the high velocity within the ductwork system.

Plate type dampers shall be made up as detailed elsewhere and shall be complete assemblies comprising plate (hinged) fusible link assembly, plate stops and steel casing having the same rating as the plate.

c) Shutter type - HEVAC/HVCA installation frames on duties up to 1500mm x 1000mm maximum for building into concrete floors/walls and brickwork.

Retaining angles/packing on ducts 1500 - 3000mm wide x 1000mm deep.

Ducts over 1000mm deep split into line or more separate assemblies with a 150mm concrete lintel between each assembly.

Upon completion of the installation, perform operating tests on each fire damper to demonstrate that all units will function as intended. This test shall consist of causing the fusible links to fuse observing that each opening will automatically be sealed. The dampers, upon successful completion of the tests, shall be reset and re-linked open with new fusible links.

Fire dampers required to be built into walls or floors shall be supplied with galvanised sheet metal casings having a thickness of at least 1.6mm and provided with galvanised steel building ties to enable the casing to be laid into the structural opening provided.

Fire dampers installed in ductwork outside the fire barrier, i.e. not built in, shall be provided complete with either extended casings to pass through the fire barrier, or provided with independent sleeves to be built into the fire barrier. In both cases the extended casing or sleeve shall be constructed from minimum 3mm thick steel plate galvanised after manufacture, fitted with building ties to enable casing/sleeve to be tied into the structural opening provided.

Maximum size of a single fire damper shall be 1000mm x 1000mm for vertical opening (horizontal duct) and 1000 x 600mm for horizontal opening (vertical duct). If a wall or floor penetration by a duct requiring a fire damper results in a larger opening, then multiple fire damper units shall be used. Where multiple dampers are installed galvanised sheet steel closure strips shall be provided to make a composite unit damper.

Fusible links shall be 70°C rating, with rating stamped thereon. In addition to supplying and installing all new links as replacements after demonstration tests, provide and hand to the Services Consultant spare links.

Supply and install for each fire damper a minimum of 400mm high x 300mm wide access door in connecting box located such that the fusible link and latching mechanism is readily accessible for inspection, testing and resetting.

Access doors shall also be located so that they are readily accessible without removing or dismantling ducts, pipes, hangers, and other building elements except for removable ceiling panels or access panels.

Fire dampers shall be selected, installed and constructed to match the fire ratings of the fire compartment walls/floors to which they are connected. The Mechanical Contractor shall obtain from the Manufacturer proof of the capabilities of the selected dampers to meet the requirements by testing or the production of an authenticated certificate of test on the type of damper offered.

.28 FIRE STOPPING

Fire stopping shall be applied to all pipes and ducts passing from one fire zone to another, and shall generally be as supplied by Dufaylite Developments Ltd.

On ductwork, where no shutter type fire damper is indicated, the Mechanical Contractor shall install a "Fireblock Ultra" intumescent fire damper of the same fire rating as the wall through which it passes.

Pipework shall have "fire sleeves" to comply with BS476, giving a 4 hour protection, and suitable for

the material used.

Where larger openings are made, "Sealbag" fire resistant pillows shall be used to give a 4 hour protection and provide facility for relocation.

In smaller openings, or where a non-standard opening is formed, Silicone 4 sealant or Interdens paste shall be used to maintain a 4 hour integrity.

.29 TESTING AND COMMISSIONING OF DUCTWORK SYSTEMS

Tests shall be performed in the presence of the Services Consultant. Notify the Services Consultant in sufficient time (in no case less than 72 hours) to allow witnessing when a test is being conducted. All defects uncovered by the tests shall be promptly corrected and tests repeated until approved. Any damage resulting from tests shall be repaired and/or damaged materials replaced free of charge to the satisfaction of the Services Consultant.

All tests shall be to CIBSE Commissioning code A.

Where required, all ductwork systems shall be pressure tested on a section-by-section basis during the course of installation and before the ductwork is enclosed or terminal units are installed all as specified herein.

The air leakage tests for ductwork shall be in accordance with Appendix A. No section of the ductwork shall be pressure tested until the jointing sealant has cured. Records shall be kept of each system tested. These reports shall be signed by the Services Consultant to whom two copies of each shall be transmitted. Reports shall contain the information shown on the standard test sheet in Appendix A.

The Services Consultant shall select at random a maximum of 10% of the duct system to be tested for air leakage. The duct shall be tested at the pressure recommended in Table 17 of DW/144 for the classification for the section of ductwork that is to be tested.

The tests shall be carried out as the work proceeds and prior to the application of thermal insulation.

In the event of test failure of the randomly selected section, the designer shall have the right to select two further sections at random for testing. Where successive failures are identified there shall be the right to require the Mechanical Contractor to apply remedial attention to the complete ductwork system.

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

.30 PLANT COMMISSIONING

All plant items shall be commissioned by the manufacturer or supplier where possible, to ensure that all warranties and guarantees are maintained. If this is not possible, a specialist commissioning Services Consultant shall be employed to commission all plant and shall issue a certificate confirming that the items have been commissioned in strict accordance with manufacturer's instructions.

Where possible, details of the manufacturer's testing and commissioning instructions shall be included within the handover manual.

.31 TEST EQUIPMENT

The Mechanical Contractor shall provide all the test equipment required for the tests as specified and shall demonstrate the accuracy of such test equipment before the test is carried out. The test

equipment shall provide a controlled and stable source of air under pressure.

It shall incorporate a device for the measurement of the rate of delivery of air flow within an accuracy of ±5% at the permissible leakage rate. To carry out the tests, a test apparatus shall be provided comprising a fan or pressure blower, calibrated orifice meters and dampers for adjusting the fan volume and system pressure. The test fan provided shall deliver a volume of air per second not less than 50% of the volume of the duct section to be tested. Instruments for reading test pressure and pressure drop over the orifice meters shall also be provided.

.32 ADJUSTING AND BALANCING

Air system balancing shall generally be undertaken and accomplished by a qualified agency specialising in this work, unless otherwise authorised by the Services Consultant to CIBSE Commissioning Code A. All work by this agency shall be done by qualified and trained personnel using methods and procedures, equipment and instruments approved by the Services Consultant. All instruments shall be accurately calibrated and maintained in perfect working order.

Air system balancing shall include, but not necessarily be limited to, the testing and adjusting of all air moving and handling equipment, dampers, air inlets and outlets, air regulation and distribution control devices to accomplish the proper flows, patterns and distribution as required for the design. Air balancing also includes furnishing to the Services Consultant for Approval complete air balance reports. Further, the air balance agency shall, at the request of the Services Consultant and at no additional charge, within 90 days from final acceptance re-check, adjust and reset any device, equipment or system originally included in the initial balance work.

Air handling and distribution systems shall be complete and operational prior to the start of adjusting and balancing. Where completion of other works such as ceilings, electrical controls, insulation, glazing etc. has an influence on the final performance of the air distribution, balancing shall not be started until they are completed or progressed far enough to have no detrimental effect.

Under no circumstances allow fan motors to be operated overloaded or fans to be operated with associated duct or casing dampers fully closed resulting in excessive pressure. Tolerance for volume shall be 0 to +5%.

Submit three copies to and obtain approval from the Services Consultant on all final balancing reports. Reports shall include, but are not necessarily limited to, all pertinent flow, temperature, pressure and velocity data, operating conditions for air mixing and moving equipment, times, dates, systems designations, locations and any other significant information for all systems.

.33 BOILER HOUSE VENTILATION

All boiler houses shall have adequate high and low level ventilation to meet the requirements of the gas safety regulations. The Mechanical Contractor shall ensure that ventilation provisions are adequate before commencing the work. The openings shall not be lockable or adjustable and shall include vermin screens.

Where flue dilution systems are incorporated, the Mechanical Contractor shall ensure that all fan suction connections are connected to outside air. No air shall be drawn from the boiler house served by such a fan system to avoid reducing the air available for proper combustion.

.34 TEST PLUGS

On both sides of all plant equipment, commissioning valves, regulating valves, and as required to correctly balance the system, the Mechanical Contractor shall install suitable test points with cap as manufactured by Test Points Ltd, of a size and type suitable for the service that they serve.

.35 VIBRATION

All equipment shall be installed in such a manner as to ensure that no vibration is transmitted to the building fabric.

All plant items with motors shall have suitable anti-vibration mountings to the manufacturer's recommendations, fitted in such a way that they absorb all detrimental plant motion. Flexible connections shall be used on all ductwork connections to fans or air handling plant whether indicated on the drawings or not.

Connections to all floor mounted pumps or pressurisation units shall incorporate neoprene or rubber flexible joints on the connections to the pipework. These shall be supported in such a way as to prevent sagging and shall be installed between the plant isolating valve and the plant item itself.

.36 MECHANICAL SERVICES WIRING

The Mechanical Contractor shall include for the complete electrical installation to the mechanical services installation.

This shall include for the supply and installation of all necessary inter-connecting wiring, local isolating switches, plug and sockets etc. together with the following items:

a) The installation of power wiring.
b) The installation of all control wiring to items of equipment and sensors within building.
c) Earthing and provision of all equipotential earth bonding to all pipe and metalwork.

Wiring shall utilise the containment system provided by the Electrical Mechanical Contractor. Wiring shall be carried out in PVC insulated single or multicore cables (as required) cables run in HG PVC conduit. Provision shall be made to provide by the Mechanical Contractor for adequate RCD protection for concealed low-voltage cables, or otherwise provide extra-low-voltage cables.

The Mechanical Contractor shall take note that all wiring 'drops' to detectors etc. shall be flush in the building fabric and enclosed in HG PVC conduit forming a vertical and re-wireable wiring route between the outlet and the ceiling void. All such conduits shall be installed by the Electrical Mechanical Contractor.

Separate green/yellow circuit protective conductors shall be installed for each circuit and shall, unless stated otherwise be of the same cross sectional area as the phase conductors.

Final connections to circulating pumps etc. shall be made with multi core HOFR flexible cables to BS6500 via multi pin plug and socket (number of poles to suit).

Where cables pass through a wall or ceiling, the Mechanical Contractor shall ensure that the integrity of that wall/ceiling is maintained against the passage of fire; and shall supply and installing all protective measures necessary.

On completion of all work and before the plant is put into operation the Mechanical Contractor shall ensure that all overloads, thermostats etc., are set up and functioning correctly and that all motors and pumps etc. are rotating in the desired direction to give the desired control function.

On completion the whole of the Electrical Installation specified herein shall be tested by the Electrical Contractor in accordance with BS 7671: 2008 (2011).

The Mechanical Contractor shall obtain Completion and Test Certificates and forms from the NICEIC. These forms shall be completed and signed by the Electrical Contractor for inclusion within the Operating and Maintenance Manual.

.37 BEMS AND AUTOMATIC CONTROLS

.01 GENERAL

.01 **SYSTEM REQUIREMENTS**
Select control components and equipment, suitable to meet system objective requirements. Ensure that system safety complies with BS EN ISO 13849.

Where necessary comply with BS EN 61508, BS EN ISO 16484-2 and BS EN ISO 16484-3.

.02 **CONTROL SYSTEM**
Provide a Building Management System (BEMS) to meet the particular requirements.

Provide a Building Management System, including:

- equipment design
- development of design
- supply
- installation
- commissioning
- setting to work
- operator training
- maintenance contract.

.03 **CONTROLS SPECIALIST**
Use a controls specialist to design, supply, install, test and commission complete controls installation.

.04 **CONTROL COMPONENTS MANUFACTURER**
Unless otherwise indicated use control components and equipment from one manufacturer throughout.

.05 **GENERAL REQUIREMENTS - ELECTRICAL SAFETY**
Ensure that the BEMS complies with the following EC Directives
Low Voltage Directive 73/23/EEC and amendment 93/68/EEC.
Construction Products Directive 89/106/EEC and amendment 93/68/EEC.
General Product Safety Directive 92/59/EEC.

Ensure that the BEMS installation complies with BS 7671 Electrical Installations in Buildings.

Ensure that control panels comply with BS EN 60439-1 Low-voltage Switchgear and Control Assemblies.

.06 **GENERAL REQUIREMENTS - ELECTRICAL SUPPLY**
Ensure that the BEMS can operate when supplied with electricity conforming to BS EN 50160 – Voltage characteristics of electricity supplied by public distribution systems.

.07 **GENERAL REQUIREMENTS - EMC**
Ensure that the BEMS complies with the Electromagnetic Compatibility (EMC) Directive 89/336/EEC.

Ensure that the BEMS complies with BS EN 61000-6-3 Generic emission standard, BS EN 61000-6-1 and BS EN 61000-6-2 Generic immunity standard.

Ensure that the BEMS meets the EMC requirements of PREN 13646.

.08 **GENERAL REQUIREMENTS - EMERGENCY RESTORATION PROCEDURES**
Ensure that the BEMS fully restores all control and monitoring functions following an emergency shut-down period.

Strategy for phased restoration of plant operation Time period for restoration of plant
Ensure that the start delay times can be adjusted according to the magnitude of the load.

.09 **GENERAL REQUIREMENTS - UNINTERRUPTIBLE POWER SUPPLY FACILITY**
Uninterruptible power supply unit to be provided.

.10 **GENERAL REQUIREMENTS - TIME SYNCHRONISATION**
Ensure that all time-dependent BEMS components are time synchronised via the operator workstation.

Ensure that the BEMS can automatically change between British Summer Time (BST) and Greenwich Mean Time (GMT).

Ensure that the BEMS can accommodate leap years.

.11 **GENERAL REQUIREMENTS - SYSTEM SECURITY**
Provide, as a minimum, password-protected operator access for the following levels.

- Level 1 - Ability to display all point data
- Level 2 - Ability to display all point data and to initiate data logging functions
- Level 3 - Ability to display all point data; to initiate data logging functions; and to change set points and time schedules

- Level 4 - Ability to display all point data; to initiate data logging functions; to change set points and time schedules; and to change control strategies and schematic/graphics functions and password assignment.

Ensure that password-protected operator access is set up for both operator workstations and field controllers which have an operator interface.

Ensure that passwords permit at least 6 alpha/numeric characteristics.

Ensure that the BEMS software is protected from unauthorised entry.

Ensure that the BEMS, and its operation performed under any maintenance contract, complies with BS ISO/IEC 27001 and BS ISO/IEC 17799 Code of practice for information security management.

.12 **GENERAL REQUIREMENTS - SYSTEM SOFTWARE**
Ensure that IT industry standard operating systems are used.

Ensure that copies of all BEMS vendor-specific software are held by an independent third party and that this software can be released to the Client.

Ensure that the ESCROW Agreement is completed and signed.

Ensure that licences to use software applications are owned by the Client.

Use communications protocol to BS EN 14908.

Provide application software written in accordance with BS 7649 Software.

.13 **GENERAL REQUIREMENTS - CHOICE OF CONTROL STRATEGY**
Where a novel control strategy is to be implemented, ensure that testing/evaluation is performed to confirm its suitability.

.14 **GENERAL REQUIREMENTS - DESIGN FOR COMMISSIONABILITY**
Ensure that the BEMS specification details required for commissioning are made available to the BEMS commissioning Services Consultant.

Ensure that all field controllers, sensors and controlled devices are easily accessible and can be removed for testing and future maintenance.

Liaise with the Mechanical Contractor to ensure that air handling units are provided with appropriate access doors.

Ensure that access is available to all control devices.

Ensure that the requirements of the following documents are met:

- Space and Weight Allowances for Building Services Plant - Inception Stage Design. BSRIA. TM 9/92
- Space Allowances for Building Services Distribution Systems - Detailed Design Stage. BSRIA. TM10/92.

Ensure that sensors are installed correctly in order to give representative readings.

Ensure that reference labels are attached to each control device.

.15 **GENERAL REQUIREMENTS - FUTURE SYSTEM EXPANSION**
Ensure that the BEMS is capable of dealing with a future 20% increase in the number of points without compromising the system's functionality or speed of operation.

.16 **GENERAL REQUIREMENTS - DESIGN FOR MAINTAINABILITY**
Ensure that a full O&M manual is prepared which reflects any system changes made during the installation and commissioning stages.

Ensure that adequate access to BEMS equipment and components is provided.

Ensure that all components and wiring are identified by a consistent numbering system.

.17 **GENERAL REQUIREMENTS - SYSTEM SUPPORT**
Ensure that a viable strategy is in place to fully support the BEMS for a minimum of 10 years from the date of practical completion.

.18 **GENERAL REQUIREMENTS - SYSTEM MAINTENANCE**
Provide maintenance support for 1 year in accordance with BSRIA BG 4/03 - BEMS Maintenance Guide.

.02 OPERATOR WORKSTATION - OPERATIONAL CHARACTERISTICS

Ensure that the control of plant is independent of the operator workstation.

Ensure that no data of a control nature is transferred between field controllers via the operator workstation, i.e. data relating to control strategies.

Ensure that the operator workstation can communicate with all addressable field controllers.

Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.

Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field controllers.

Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the operator workstation.

Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.

Ensure that the operator workstation incorporates a data storage management system that warns against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-line non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.

Ensure that it is possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.

Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data). Note that the use of multiple 3.5 inch disks is not acceptable.

Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.

Ensure that the backup data can be fully re-loaded.

Ensure that selected files from the backup data can be re-loaded.

.01 **OPERATOR WORKSTATION EQUIPMENT**
Standard BS EN ISO 16484-2 and BS EN ISO 16484-3.

Workstation

- To exceed minimum requirements recommended by manufacturer

Processor

- Ensure that the processor speed of each operator workstation meets the data processing requirements.
- Ensure that the processor speed is such that delays in processing system data do not exceed

Monitor

- Use a colour monitor with a resolution to exceed minimum requirements recommended by manufacturer

User access

- Provide a QWERTY keyboard with full upper/lower case ASCII key-set, numeric keys and mouse.

Printer

- Ensure that the printer can print all monitored and logged data (including graphs of logged data); all point data (hard and soft); control logic diagrams and plant/building; schematics in colour; alarm data/text; and system help text.
- Ensure that the automatic printing of alarm data can be switched on/off.

.02 **OPERATOR WORKSTATION - MONITORING AND LOGGING FUNCTIONS**

Ensure that all monitored point data can be displayed at the operator workstation.

Ensure that analogue, digital and soft-points can be displayed simultaneously.

Ensure that all changes made by the operator (e.g. set-point changes) can be logged and identified by both operator and date/time stamp.

Provide a facility to allow the display, at the operator workstation, of 'real time' data superimposed on plant schematics with a refresh rate not exceeding 20 seconds.

Ensure that a minimum of four 'real time' data points can be displayed simultaneously, in the form of data plots, with a time delay not exceeding 20 seconds.

Provide a facility to allow the monitoring and display, on the same 'page', of common criteria/plant functions.

Ensure that any hard or soft-point log can be displayed and stored on the operator workstation.

Ensure that logs can be set up from the operator workstation and that logging times and logging intervals are user adjustable between 1 second and 24 hours.

Ensure that the operator workstation has sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.

Amount of logged data

Provide a facility to allow the simultaneous display of different logged data. Ensure that this function is operator adjustable.

Provide a facility to allow the export of logged data to other software packages. Ensure that the format of the exported data can be fully defined.

Requirements: comma separated values.

.03 **OPERATOR WORKSTATION - GRAPHICAL OPERATOR INTERFACES**

Provide graphics as part of technical submission for review and approval by the Services Consultant.

Provide a software library of plant schematics and symbols, the format/contents of which should be confirmed with the specifier based on samples.

Provide a facility to allow the operator to generate additional schematics and symbols.

Ensure that the system can accommodate the addition of 20% extra graphics 'pages'.

Provide a facility to allow the operator to modify plant schematics and to generate new ones.

Ensure that graphics can be displayed in a layered approach (building layout graphics down to plant subsystems and components).

Ensure that the operator can modify the structure of the layered approach.

.04 **OPERATOR WORKSTATION - HELP AND ASSISTANCE**

Provide a facility to allow the display of help text covering all operator functions and system fault conditions.

Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy logic schematics.

.05 **OPERATOR WORKSTATION - INTEGRATION WITH THIRD PARTY MANAGEMENT SOFTWARE**

Energy monitoring and targeting software

Provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BEMS to the monitoring and targeting software.

Ensure that the format of the exported data can be fully defined.

Requirements: comma separate values.

Maintenance management software

Provide a facility to allow the direct transfer between the BEMS and the maintenance management software of plant run hours; number and frequency of plant starts; critical alarms requiring immediate attention; and maintenance (non-critical) alarms.

.06 **OPERATOR WORKSTATION - SYSTEM ALARMS**

Ensure that alarms are displayed on a rolling basis in chronological order.

Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators.

Provide a facility to silence audible alarms or inhibit flashing annunciators without performing alarm acknowledgement.
Ensure that alarms can be inhibited for reasons of time and/or priority as selected by the operator.

Ensure that the BEMS can be configured to avoid fleeting alarms, i.e. ensure that alarms can accommodate start-up and shutdown delays.

Ensure that the operator can alter the limits at which the measured values cause alarms to be triggered.

Ensure that alarms can be limited to the source items(s) of plant.

Ensure that alarm limits can accommodate sliding limits, e.g. set-point changes.

Ensure that alarms can be differentiated by means of alarm type and identification.

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

Ensure that the time taken to receive alarms does not exceed.

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

Ensure that the reception and acknowledgement of alarms can take precedence over other operations.

However, ensure that the reception of alarms does not hinder user log-in.

Allow the user to acknowledge alarms individually and on a group basis.

Acknowledgement should include muting or flashing annunciators.

Provide distinction between active alarms whose conditions are not cleared and unacknowledged alarms.

Provide an alarm-latching facility with manual reset.

Ensure that alarm data provides condition identity; condition value; alarm source; alarm time and date; and acknowledgement status.

Ensure that the alarm file can be sorted by the above criteria.

Allow alarms to be automatically redirected to other user interfaces.

Provide sufficient data storage capability for the storage of alarms.

Ensure that any stored alarm data can be analysed in conjunction with other monitored conditions or stored logged data.

Ensure that an alarm review facility is available.

Allow the display of stored alarm data based on user definable selection criteria.

Ensure that the operator can define the requirement for acknowledgement of alarms; a time programme for annunciation of alarms to different destinations; and text messages associated with alarm conditions.

.03 FIELD CONTROLLERS - GENERAL

Manufacturer and reference: Trend IQ3 or approved equivalent

- Standard BS EN ISO 16484-2
- Mounting In control panel
- Casing material Rigid plastic

.01 **FIELD CONTROLLERS - MODES OF OPERATION**

Ensure that all field controllers can operate independently and in real time following a failure of the BEMS communication network.

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

.02 **FIELD CONTROLLERS - PHYSICAL CONSTRUCTION**

For internal plant room applications, construct field controller enclosures to give a minimum degree of protection to IP54 in accordance with BS EN 60529.

Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41.

For external applications, construct field controller enclosures to IP65.

Where an enclosure is to be provided ensure that field controller enclosures are lockable.

Ensure that modular construction is used for field controllers. Ensure that this allows the removal and replacement of devices without the need for rewiring of field wiring.

.03 **FIELD CONTROLLERS - TERMINATIONS**
Manufacturer's standard.

.04 **FIELD CONTROLLERS - FUTURE EXPANSION**
Make provision for a future 25% increase.

.05 **FIELD CONTROLLERS - CONTROLLER INPUTS**
Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices. Ensure that the following requirements are met.

Analogue input

- Variable currents (4-20 mA), variable voltages (0-10V) or variable resistances.
- Ensure that the routines necessary to process analogue inputs are resident at the field controller.
- Ensure that a minimum and maximum limit value can be defined for each analogue input.
- Ensure that each limit is associated with a configured response.
- Ensure that the field controller can detect open or closed circuit faults and raise an alarm on the operator workstation.
- Ensure that non-linear inputs can be calibrated/scaled.
- Ensure that it is possible to define a relationship between an analogue point threshold value and a digital point status.

Digital inputs

- As derived from volt-free contacts (max 24 volts/20mA). Allow the interface to be selected to monitor a normally open or normally closed circuit.
- Ensure that the routines necessary to process the digital inputs are resident at the field controller.

Pulsed inputs

- As derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 32Hz.
- Ensure that the routines necessary to process pulsed inputs are resident at the field controller.
- Ensure that the field controller has the following capabilities.
- Storage of cumulative totals daily; weekly; monthly; yearly; and continuously.
- Operator re-set facility of cumulative totals via the operator workstation.
- Facility to combine counts from separate pulsed inputs.
- Ability to calculate the number of pulses per unit time through addition and/or subtraction.
- Ability to compare the number of pulses with pre-set limits on the basis of total number of pulses per unit time and the time required for a total number of pulses.
- Ability to convert pulsed readings into quantifiable values.
- Alarm facility based on a user-defined limit being exceeded.
- Ensure that the inputs which are used to monitor fluctuating pulse rate (e.g. maximum Ensure that when data for pulsed inputs is recorded, the record includes both the pulse count and logging intervals for cumulative counts.

Run-time totals

- Include run-time totalling routines to enable the operator to record cumulative run-time for each item of plant selected.

- Provide the operator with the option to set a different maximum run-time for each item of plant selected.
- Ensure that when the maximum run-time has been reached an alarm is signalled to the operator.

- Ensure that the operator workstation can be used to interrogate field controllers for a point-by- point summary of run-time totals and run-time limits.
- Ensure that it is possible for the user to set an initial value of hours run other than zero.

General

- Ensure that all inputs can be scanned at intervals not exceeding 1 second.
- For time-critical control applications, ensure that the field controller can scan at a time interval not exceeding
- Ensure that all inputs are protected against spurious out-of-range signals including those caused by contact noise or bounce.
- Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 0.1% of the analogue value.

.06 **FIELD CONTROLLERS - CONTROLLER OUTPUTS**

Ensure that isolation between controllers and networks meet the requirements of PREN 13646.

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

Ensure that routines are configurable, such that one or more events may be enabled in direct response to any defined logical relationship between the status of a number of physical or soft- points.

Ensure that in the event of power failure, output devices can be driven to their pre-set, fully open/closed position.

Provide the following interface characteristics:

Analogue output. As variable currents (4-20mA) or as variable voltages (0-10V). Ensure that it is possible to characterise analogue outputs in order to obtain a near linear response from the controlled items of plant.

Digital output. Ensure that digital outputs can be selected as 'normally closed' or 'normally open'.

Ensure that errors introduced by the digital to analogue conversion of outputs do not exceed 0.1% of the digital value.

Ensure that the field controller is capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.

.07 **FIELD CONTROLLERS - POSITIVE FEEDBACK**

Ensure that the field controllers can include routines necessary to confirm that specific items of plant are functioning correctly. Ensure that this can be performed by monitoring physically separate but functionally related sensors, switches or transducers.

Ensure that an alarm is raised if the expected response has not been established by a pre-set time following switching on of plant.

Ensure that it is possible to operate any specified standby plant.

Provide the operator with a facility to adjust the pre-set time delay.

Ensure that the field controllers are capable of using measured feedback from an actuator position to give a percentage open reading.

.08 **FIELD CONTROLLERS - DATA MONITORING AND LOGGING**
Ensure that hard and soft-points associated with a field controller can be logged.

Ensure that the BEMS operator can set the start/stop times and logging frequency at the operator workstation.

Ensure that logging is selectable between fixed periods or on a rolling basis.

Ensure that each log can be defined in terms of log identification (point identification); units; and date/time stamp.

Ensure that the operator can select all physical and soft-points for logging.

Ensure that the field controller has sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points on the field controller.

Ensure that when the logging capacity of a field controller is exceeded, the data can be automatically downloaded to the operator workstation and archived.

.09 **FIELD CONTROLLERS - ENVIRONMENTAL CONDITIONS**
Ensure that field controllers are suitable for operating normally within the following environmental ranges:

- Temperature 0 to 50oC
- Relative humidity 10% to 90% non-condensing.

Ensure that the field controllers will operate in the electrical environment associated with building services plant rooms.

Ensure that the EMC requirements specified in W60 are met.

Ensure that the field controllers are protected against the effects of moisture, dust, dirt and gases.

.10 **FIELD CONTROLLERS - INTERNAL POWER BACKUP**
Provide internal power backup.

Ensure that a rechargeable battery or capacitor, if specified, can hold the controller's volatile memory for a minimum period of 72 hours.

Ensure that a non-rechargeable battery, if specified, can maintain the controller's clock function for a period of two years.

Ensure that the battery is easily replaceable.

Ensure that the interval between battery maintenance inspections is not less than 12 months.

Ensure that any battery monitoring functions defined in the Particular Inspection can be met.

.11 **FIELD CONTROLLERS - MEANS OF CONFIGURATION**

Ensure that the field controllers can be fully configured directly via a laptop type computer and via the operator workstation.

Ensure that the field controllers can be configured through the use of a configuration interface with full upload and download capability.

Ensure that configuration details can be easily altered by system operators.

Ensure that access to make configuration alterations is restricted to operators with access authority through the use of passwords.

.12 **FIELD CONTROLLERS - USER INTERFACES**

Ensure that all field controllers can be accessed through the use of portable computers.

Ensure that access allows the display of all configuration details associated with the field controller along with:

- Password protection for access with a minimum of two access levels
- Ability to display all point data (both hard and soft)
- Ability to initiate and display logged data
- Ability to display and alter set-points and time schedules
- Ability to make alterations to control strategies.

Ensure that field controllers incorporate a panel-mounted operator interface. Ensure that the interface includes the ability to:

- Provide password protection for access with a minimum of two access levels
- Display all physical point data
- Display and alter set-points and time schedules
- Display the current date and time
- Review and acknowledge alarms
- Access logged data.

.13 **OCCUPANT CONTROLS - GENERAL**

Manufacturer and reference: Trend or approved equivalent.

Ensure that the specified occupant controls can be linked to, and communicate over, the BEMS communications network.

Ensure that the occupant controls can control the relevant items of plant.

Ensure that the status of each occupant controller can be viewed and overridden via the operator workstation.

Ensure that the occupant controls allow:

- Adjustment by the occupants of the set-points
- Definition, and adjustment by the BEMS operator, of high and low limits for each set-point control.

Provide a facility to allow the global alteration of set-point and high/low limits via the operator workstation.

Provide an override facility to allow plant operation during out of hours occupation.

Ensure that the occupant controls are intuitive to use and clearly labelled.

For temperature control ensure that hot/cold and/or red/blue indication is used for the occupant interface.

For fan speed control ensure that fan fast/slow indicators are used.

Ensure the +/- symbols are not used without clarification of the controlled function.

Wall/desk mounted.

.04 OCCUPANT CONTROLS – OFFICE/INTRANET BASED

Ensure that the occupant controls are TCP/IP compatible.

.05 CONTROL FUNCTIONS AND ROUTINES – GENERAL

See particular specification.

.01 **CONTROL FUNCTIONS AND ROUTINES - BASIC CONTROL FUNCTIONS**
See clauses under W60 within Part 1 of this specification.

.02 **CONTROL FUNCTIONS AND ROUTINES - CONTROL INTERLOCKS**
Ensure that the BEMS is capable of providing all control interlocks detailed.

Safety interlocks

- Ensure that all safety interlocks are hardwired and have precedence over all other control functions
- Ensure that safety interlocks can only be reset manually and locally (not from the operator workstation)
- Ensure that all hardwired safety interlocks have corresponding software interlocks to prevent cascading nuisance alarms.

.03 **CONTROL FUNCTIONS AND ROUTINES - TIME SCHEDULES**

See Particular Specification.

.04 **CONTROL FUNCTIONS AND ROUTINES - PLANT START/STOP CONTROL**

See Particular Specification.

.05 **CONTROL FUNCTIONS AND ROUTINES - SEQUENCE CONTROL**

See Particular Specification.

.06 **CONTROL FUNCTIONS AND ROUTINES - PLANT ROTATION CONTROL**

See Particular Specification.

.07 **CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR HEATING SYSTEMS**

See Particular Specification.

.08 **CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR COOLING SYSTEMS**

See Particular Specification.

.09 **CONTROL FUNCTIONS AND ROUTINES - WEATHER COMPENSATION**

See Particular Specification.

.06 SYSTEM COMMUNICATIONS – GENERAL

Ensure that the system communications allow the full transfer of monitored, logged, alarm, backup and configuration data between the operator workstation and addressable field controllers.

Ensure that the communication protocol selected seeks to achieve error-free data transfer.

Ensure that the protocol includes an error detection check; includes an error correction and/or re-try technique; limits retransmission; and raises an alarm condition on failure.

Ensure that the available bandwidth is sufficient to avoid excessive delays in transmitting data.

Ensure that the maximum permissible time delay does not exceed 5secs.

.01 **SYSTEM COMMUNICATIONS - COMMUNICATION DEVICES**
Ensure that connections to telecommunication systems complies with BS 6701. Provide a broadband link.

TCP/IP
310.460 SYSTEM COMMUNICATIONS - COMMUNICATIONS PROTOCOLS:

- BS EN ISO 16484-5
- BS EN 61030
- BS EN 61158-2
- Modbus
- Lontalk
- Proprietary e.g. Trend LAN)
- Field-level protocols

Ensure that the selected protocol can:

- Run on the required communications media
- Provide a communications throughput sufficient for the intended application
- Provide appropriate network topology options
- Allow sufficient maximum physical segment length
- Allow sufficient maximum number of nodes for each physical segment and the logical network
- Provide sufficient maximum distance between nodes
- Make use of off-the-shelf network devices such as repeaters, bridges and routers
- Allow control devices to be powered from the network.

Ensure that the protocol is compatible with fully developed network configuration and management tools.

.02 **SYSTEM COMMUNICATIONS - DIRECT INTEROPERABILITY**
Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.

Ensure that each of the protocol's arrangements for physical connection, data packaging, network management and error detection/correction are the same.

.03 **SYSTEM COMMUNICATIONS - GATEWAYS**
Ensure that the gateway can:

- Transfer the specified maximum number of points
- Limit loss of functionality to the level specified
- Add functionality where specified
- Limit any time delay across the gateway to the maximum.

Ensure that the specified contingency and alarm measures in response to a failure of the gateway are met.

Ensure that the gateway can be modified in response to any future changes relating to the type and amount of data transferred over it.

Clearly define who has contractual responsibility for the implementation of the gateway.

.07 SENSORS AND DETECTORS - GENERAL

Interface sensors with controllers and indicators via amplifiers or transmitters, where necessary.

Ensure that all signals are compatible with interfaces fitted to associated field control devices.

Ensure that the performance of the sensors and detectors are not adversely affected by the following variations in power supply conditions: 230V+10%, -6%.

Ensure that connections to sensors and detectors are of a screw down clamp type or self-locking connectors.

Ensure that sensors, detectors and meters are installed in accordance with the manufacturer's instructions and recommendations.

Ensure that calibration conditions for meters are fully documented in the O&M manuals and clearly marked on or adjacent to the meters.

Ensure that any calibration and maintenance requirements for sensors, detectors and meters are documented in the O&M manuals.

.01 SENSORS AND DETECTORS - TEMPERATURE SENSORS

Standard
BS EN 60730-2-9 and BS EN 14597

Use thermocouple assemblies consisting of element, sleeve and connector.
Connect thermocouple assemblies to a digital indicator/control unit.

Analogue indicator/control unit.

Method

- Directly
- Indirectly.

Sensor

- Duct
- Room.
- Outside air
- Water
- Time constant Space/outside air temperature - 300s still air.
- Duct air temperature - 120s @ 1m/s.

- Water - 30s @ 1m/s.

Ensure that temperature sensors comply with the minimum requirements of the following table.

Temperature Sensors – Minimum Requirements

Fluid	Temperature Range °C	Sensor Accuracy °C
Air	-10 + 40	± 0.5
Flue gas	+ 30 to + 850	± 3.0 (0.75% of FSD above 450°C)
Chilled water	-10 to + 30	± 0.25

.02 **SENSORS AND DETECTORS - HUMIDITY SENSORS**
Standard - BS EN 60730-2-13.

Measurement
- Relative humidity.
- Time constant - 300@ 1m/s.

Ensure that humidity sensors comply with the minimum requirements of the following table.

Humidity Sensors – Minimum Requirements

Sensor	Humidity Range	Sensor Accuracy
Humidity	10 to 90%	± 5% RH

.03 **SENSORS AND DETECTORS - AIR VELOCITY SENSORS**
Method
- Pitot static tube.
- Thermo-electric anemometer.

Ensure that air velocity sensors comply with the minimum requirement of the following table.

Air Velocity Sensors – Minimum Requirements

Sensor	Sensor Range	Sensor Accuracy
Pitot static tube	3 to 80 m/s	± 2% of reading
Thermo-electric anemometer	0 to 20 m/s	± 3% of reading or ± 0.1 m/s, whichever is greatest

.04 **SENSORS AND DETECTORS - AIR PRESSURE SENSORS**
Use pressure transducers manufactured in stainless steel.

Voltage output
- Accuracy
- Connect pressure transducers, via matched transmitters to
- Single way display/alarm/control unit
- Multi-way display/alarm/control unit.

Ensure that air pressure sensors comply with the minimum requirements of the following table.

Air Pressure Sensors – Minimum Requirements

Sensor	Sensor Range	Sensor Accuracy
Air Pressure	-	± 2% of reading

.05 **SENSOR AND DETECTORS - FLOW SENSORS**
Standard - BS EN 60730-2-18.

Provide flow detectors and connect to display/alarm/control unit Sensor

- Differential pressure transducer.
- Time constant 5 seconds.

.06 **SENSORS AND DETECTORS - FLOW METERS**

Ensure that meters comply with the minimum requirements of the following table.

Flow Meters – Minimum Requirements

Meter	Meter Range	Meter Accuracy
Fuel flow meter	0 to 10 Hz	3% of reading
Water flow meter	>>5:1	2% of reading
Electricity meter	-	1.5% of reading

.07 **SENSORS AND DETECTORS - LEVEL SENSORS**
Provide liquid level detectors and connect, via matched amplifiers, to single way display/alarm/control units.

Multi-way display/alarm/control units.

Sensor
- Use capacitance electrodes manufactured from stainless steel and PTFE insulation for use on conductive liquids with a minimum conductivity of 0.01 S/m
- Use conductivity electrodes manufactured from stainless steel, either single or multi-tipped
- Float type to BS EN 60730-2-16.

.08 **SENSORS AND DETECTORS - OTHER SENSORS**

Type

- Smoke
- CO2
- CO
- BS EN 50291
- BS EN 50292
- Combustible gases and oxygen
- BS EN 50271.

Sensor range:

CO and CO2 to be determined after logging ambient levels and submitting logs for review as part of the technical submissions.

Sensor accuracy: CO and CO2 to be determined after logging ambient levels and submitting logs for review as part of the technical submissions.

.09 **TRANSMITTERS**

Use transmitters to interface between sensor and controller, utilizing only one sensor.

Use transmitters

- Input
- Input span
- Zero offset
- DC
- AC
- True rms
- Voltage
- Current
- Frequency
- Pulse rate
- On/off.

Resistance

- RTD to BS 1041-3
- RTD to BS EN 60751
- Thermocouple to BS EN 60584 type
- Lead resistance
- Bandwidth
- Bias current
- Input resistance.

.10 **AMPLIFIERS**

Use amplifiers to increase/change a signal from a sensor.

.08 SWITCHES AND THERMOSTATS

.01 **AIR DIFFERENTIAL PRESSURE SWITCHES**

Adjustment range for trip pressure

Maximum operating pressure

- To suit application

Electrical rating

- To suit application

Ambient temperature limits
- To suit application

Reset differential
- To suit application

Maximum differential pressure overload
- To suit application

.02 **AIR THERMOSTATS - ROOM TYPE**
Standard
- BS EN 60730-2-9

Position
- Wall mounted

Ancillaries
- Built in set point potentiometers
- Remote set point adjustment

.03 **AIR SENSOR - INSERTION TYPE**
Use proportional type insertion sensor.

Sensor

Averaging type temperature sensor for mounting overface of air flow in an air-handling unit or in ductwork adjacent to a heating coil. Thermistor type temperature sensor, minimum stem length 200mm for mounting in the air flow or distribution ductlines.

.04 **AIR THERMOSTATS - MASTER TYPE**
Provide master type thermostats to measure conditions at one point and reset the point of another (submaster) thermostat or controller.

.05 **AIR THERMOSTATS - REMOTE BULB TYPE**
Connect via Cable

.06 **AIR THERMOSTATS - FROST PROTECTION TYPE**
Standard
- BS EN 60730-2-9
- BS EN 14597

For space mounting use frost protection thermostats with temperature range of 0-200C and with SPST switching action and electrical rating of 20 amps resistive.

For heater battery protection use frost protection thermostats consisting of a gas filled sensing element and a bulb, a directly adjustable set point and switching differential.

For compensated systems use external frost type thermostats with proportional type sensor, the whole unit being weather-proofed.

.07 **WATER IMMERSION THERMOSTATS**
Standard
- BS EN 60730-2-9
- BS EN 14597

Use proportional type immersion thermostats with rigid sensing elements, ensuring 50mm minimum length is immersed. Use separable pockets, screwed 15mm BSP.

Pocket material
- Stainless steel
- Install pockets in positions indicated.

.09 HUMIDISTATS

Enthalpy.

.10 ACTUATORS

Include position feedback devices suitable for connection to the BEMS.

Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.

Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.

.01 **ACTUATORS - SOLENOID TYPE**

Standard
- BS EN 60730-2-8.

Control mode
- Linear
- Proportional.

Operation
- Normally open
- Normally closed
- Modulating.

Ancillaries
- Spring return
- Power failure return.

Positioners.
- Manual control failures.

.02 **ACTUATORS - ELECTRONIC TYPE**

Standard
- BS EN 60730-2-8

Use low voltage, high torque, electronic type actuators, including mounting brackets, adjustable linkages and necessary attachment devices.

Control mode
- Linear
- Proportional
- Compensating.

.03 **ACTUATORS - ELECTRIC MOTOR**

Operation
- Unidirectional
- Reversible
- Synchronous

- Asynchronous.

Provide thermal overload protection with manual reset option.
Spring return.

Control mode
- Linear
- Proportional
- Compensating.

Operation
- Two-position (ON-OFF)
- Continuous
- Modulating.

Electrical requirements
- Integral terminal strip or DIN plug and socket connections
- Two end of travel limit switches, with adjustable cam operation for motor de-energisation.

Mechanical requirements
- Self-locking gear train
- Manual override, geared to prevent backdrop
- Travel stops in each direction
- Position indicator
- Enclose to IP65 minimum.

Ancillaries
- To suit application.

.11 VALVES AND DAMPERS

.01 MOTORISED VALVES

Standard
- BS EN 60730-2-8

Type
To suit application - can be:

- Single seat
- Double seat
- Three-way mixing
- Three-way diverting
- Butterfly
- Multi-port
- Low flow
- Pilot operated
- Material.

To suit application and see Particular Clauses on LTHW, DHW, CHW and CWS systems – can be:
- Brass to BS EN 12163, BS EN 12164 or BS EN 12167
- Copper alloy to BS EN 1982
- Cast iron to BS EN 1561
- Cast steel to BS EN 10213
- Connections

- Screwed to BS 21 and BS EN 10226-1
- Flanged to BS EN 1092-3
- Cast steel only, flanged to BS EN 1092-1
- Cast iron only, flanged to BS EN 1092-2
- Aluminium alloy only to BS EN 1092-4

Ancillaries
- Position indicator
- Locking device
- Control device and linkage mechanisms
- Actuating motive power
- Solenoid
- Electric motor.

.02 **CONTROL BALL VALVES**
Valve

Control valve
- Open/Close valve
- Two way
- Three way
- Rotary Actuator
- Open/close
- Modulating
- 3-point.

Material
- Nickel-plated brass
- Stainless steel ball
- Seal - PTFE
- Stainless steel spindle
- Spindle seal - EPDM.

Connections
- Threaded to BS 21 and BS EN 10226-1.

Ancillaries
- Lever for manual operation.

.03 **DAMPERS**

.04 **MOTORISED DAMPERS**
Use motorised control dampers manufactured and installed in accordance with DW 144.
Actuating motive power High torque-electronic.

.05 **MOTORISED SHUTTERS**
Use motorised shutters manufactured and installed in accordance with DW 144.
Actuating motive power

Electric motor.

.12 INSTALLATION

.01 **FIXING AND CONNECTION - CABLING INSTALLED AS PART OF THE BEMS CONTRACT**
Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.

Label and record all monitoring cables in accordance with cable schedules cable drawings.

Application

General
This part of the specification covers extra-low voltage wiring (as defined by BS 7671), i.e. signal and data communications wiring.

Install all cabling in accordance with BS 6701 and BS EN 50174.

All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.

Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc. from external sources to sensing devices.

Ensure that all wiring is carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route it to avoid interference with the correct operation or maintenance of other components.
Cable type and application

Ensure that the types of cable installed do not prejudice satisfactory operation of the BEMS.

Ensure that the type of cables, installation and planning comply with the BEMS manufacturer's recommendations and the project's electrical specification.

Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit resistance limits are not exceeded.

Ensure that the method of installation and routing of cables does not compromise the satisfactory operation of the BEMS.

Ensure that the following minimum separation distances (in mm) between data/ analogue signal cables and power cables are adhered to (not required if data/signal cables are in steel conduit or trunking).

Minimum Separation Distances between Signal Cables and Power Cables

Signal Cable	Power Cable Unscreened	Power Cable Armoured Steel Wire
Plain	150 mm	125 mm
Unscreened twisted pair	75 mm	50 mm
Screened	0 mm	0 mm

Identification
Ensure that all cables have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams.

.02 **FIXING AND CONNECTION - USE OF EXISTING CABLE AND WIREWAYS**

Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of network communication is of a suitable standard for satisfactory operation of the BEMS.

Ensure that any tests performed comply with BS EN 50174.

Ensure that the potential corruption of data cannot arise from:

- Other installations not connected to, but in close proximity to, the route of existing cabling
- Other electrical services using existing cabling
- Other adjacent cabling.

State in writing at the time of tender whether or not existing cabling is suitable.

.03 **FIXING AND CONNECTION - CONNECTION TO PLANT AND CONTROL EQUIPMENT**

General

Provide all devices and terminals necessary to connect the BEMS to items of plant and control equipment.

Take account of any existing services that have to remain in continuous operation. Agree with the Project Supervisor the method by which the BEMS equipment can be installed without disrupting the operation of the building services.

Where plant and control equipment are supplied by others, provide the Project Supervisor with adequate details of installation requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BEMS connection facilities before delivering their equipment to site.

Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed modifications do not invalidate the warranties.

Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the BEMS works. Carry out proving tests to the satisfaction of the Project Supervisor.

Ensure that the use of existing relays, contactors, starters and switches as part of the BEMS installation is fully documented.

Safety interlocks

Provide interlocks as scheduled to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power.

Ensure that all safety hard-wired interlocks are wired to failsafe on loss of power, or on relay coil failure, or on open circuit, e.g. cable breakage.

Ensure that all interlocks use voltage-free contacts and 24v AC or DC relays and field wiring.

Complete all wiring and testing of all hard-wired safety interlocks to ensure safe and/or sequenced operation of the plant before the BEMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BEMS.

Ensure that plant does not operate using the BEMS until all interlocks have been tested to the satisfaction of the Project Supervisor.

Manual control
Provide manual control facilities to enable plant maintenance/facilities staff to operate essential plant in the event of BEMS failure and for routine test purposes. Ensure that the facilities include:

Start/stop operation of the plant.

Automatic operation of motorised control devices such as valves and dampers, etc. if the BEMS is operating.

Manual setting of motorised control devices such as valves and dampers, etc. if the BEMS has failed.

Ensure that the manual control facilities do not override safety devices or hard-wired interlocks.

Volt-free contacts
Ensure that the contact materials are suitable for use in the installation and at the required voltages and currents.

Use screw down or locking spade terminals for electrical connections to volt-free contacts.

Relays
Use demountable relays of the totally enclosed type.
Use screw down clamp or locking spade-terminals, and ensure they are shrouded.

Signalling from starters
Provide additional contacts for signalling and remote operation purposes as
Control equipment.

Obtain advice from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.

Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices.

Packaged plant
Ensure that connections to packaged plant are made within the packaged plant control panel. Fit an additional enclosure where this is not possible. Ensure that all connections between the BEMS and packaged plant are 24v maximum.

.04 **FIXING AND CONNECTION - ADDITIONAL PROVISIONS FOR RETROFIT INSTALLATIONS**
Arrange for any necessary control modifications to existing plant to be carried out by the original supplier (with the exception of starter panels). Give the supplier details of the requirements for connection of equipment to the BEMS. State the name of the supplier in the Tender, together with a priced schedule for the necessary work.

Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications.

Provide the specialist with the details of the BEMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the Project Supervisor of any difficulties with connections.

Advise in writing at the time of tender of any potential delay to the contract arising from the difficulty of providing the necessary BEMS connections to the plant.

Use existing relays and volt-free contacts where feasible.

Fit auxiliary contacts to contactors, etc where adequate space is available. Install additional relays if the space is not adequate.

Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.

Use the control manufacturer's standard accessories to provide any additional contacts, limit switches and potentiometers, etc.

Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices wherever possible.

Obtain approval from the Project Supervisor for ad hoc fixings and modifications to control devices before action is taken on site.

.05 **FIXING AND CONNECTION - CABINETS FOR BEMS EQUIPMENT**

Construct BEMS equipment enclosures to give the minimum degree of protection to IP54 in accordance with BS EN 60529. Where the enclosure is fitted inside another panel (e.g. a motor control centre) the protection can be reduced to IP41.

Ensure that access doors are of a rigid construction and mounted on stout metal hinges capable of supporting the full weight of the open door. Ensure that doors will not sag or drop when open. Fit doors with stout locking handles to prevent access by unauthorised personnel.

Allow safe access to the BEMS equipment where the BEMS equipment is incorporated into another control panel without having to isolate the panel.

.06 **FIXING AND CONNECTION - CONTROL PANELS**

Control panel design

Ensure that the requirements of PREN 13646 are met.

Ensure that the layout of control panels reflects the layout of the plant being served.

Ensure that indicators and controls for associated plant are grouped.

Ensure that all doors on panels containing exposed dangerous voltages are provided with interlocked isolators such that the door cannot be opened except with the isolator in the 'off' position.

Ensure that isolation complies with BS 7671.

Ensure that equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding safety interlocks.

Ensure that, in general, field controllers are not located within control panels where isolation is necessary to gain access.

Design panels to maintain all components within their environmental tolerance limits taking into account ambient environmental conditions. Install fans with thermostatic

control and air extract grilles and air intake grilles with replaceable filters where mechanical ventilation is required to control the environmental conditions.

Ensure that the specified ingress protection (IP) ratings are maintained.

Control panel construction
Construct control panels to IP54. Construct the panels using sheet steel, folded and seam welded to form a rigid self-supporting structure. Ensure that bracing and stiffening is used, as necessary, to take the weight of internal components and control assemblies. Ensure that no sharp corners are present.

Ensure that control panels weighing more than 50 Kg including installed components are fitted with eyebolts to facilitate delivery and installation.

Ensure that panels are provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable trunking intended for termination within the panel.

Arrange all wiring within the panel in looms and/or perforated trunking. Ensure that all cables are run continuously from terminal to terminal without intervening joints.

Ensure that all terminations are fully shrouded, recessed or otherwise protected against accidental contact.

Ensure that, where live equipment cannot be isolated, it is covered with a Perspex shield carrying appropriate warning labels in addition to specified shrouding.

Ensure sufficient spare capacity in cable ways and trunking to comply with BS 7671.

Ensure that flexible looms are used to connect door mounted to interior-mounted components such that wires will not weaken or break with repeated door openings. Arrange the loom to avoid pinching or looping when the door is closed and ensure that it is fully supported at each end.

Control panel labelling
Ensure that all panels and individual panel sections are provided with exterior labels to BS 5499-5, indicating the voltage within the panel along with clear warnings of risk and instructions for isolation.

Display requirements for informing the BEMS supervisor and/or disabling alarms prior to isolation of control circuits.

Label all switches, controls and indicators on control panels as to function and associated plant.

Fix a notice to the front of the panel warning of the need for isolation elsewhere if the panel does not totally control the electricity supply to associated plant.

Identify all cables with permanently fixed ferrules. Ensure that the numbering corresponds to the numbers fixed to the terminals. Ensure that identification and coding matches are used on the design drawings, schematics and schedules.

.13 SENSORS – GENERAL

Ensure that sensors can be removed for testing and maintenance.

Ensure that a tight-sealing test hole is provided adjacent to every duct sensor. Ensure that Binder test points, or similar, are provided for pipe sensors.

Provide a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.

Mark and record the location of concealed sensors (e.g. in false ceilings and shafts, etc.). Provide a labelling plate for each sensor.

Take account of the active and inactive sections of a sensor probe.

Take into account the effects of orientation on the functioning of the sensor.

Take into account:

- Minimum/maximum ambient temperature
- Ambient humidity
- Vulnerability to spray water and/or vibration
- Explosion protection
- External influences.

.01 **TEMPERATURE SENSORS**

Pipe-mounted immersion sensors
Ensure that the full active length of the sensor is immersed in water.

Install sensors against the direction of flow.

Install at the correct angle.

The sensor should be installed diagonally in a bypass pipe or in a bend if the active length of the sensor probe is longer than the diameter of the pipe.

Allow an adequate space between the sensor and the obstruction so that the sensor can be removed from the immersion pocket.

Ensure that immersion pockets are made from stainless steel of the appropriate pressure rating.

Ensure that immersion pockets are filled with a heat conducting compound.

A test point or an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.

An adequate distance (10 x pipe O) between the mixing point and the sensor should be provided when mixing water at different temperatures to take account of stratification.

Surface temperature sensor – water
Ensure a smooth clean contact surface and fill the space between the sensor and the pipe with a heat conductive compound to improve thermal conductivity.

Immersion sensors for air (ducts)
The full active portion of the sensor probe should be exposed to the air flow.

Ensure that the active portion of the probe is located central to the airflow.

A test hole should be provided adjacent to every sensor with plug when not in use.

Probe-type sensors should not be used in areas where stratification can occur, e.g. downstream of heating and cooling coils, etc. (see averaging sensors).

Sensors which are positioned near to coils should be shielded against the radiative heat transfer.

Return air duct sensors should be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings.

Sensors must be positioned in an area of representative air flow. This applies to all duct sensors, but particularly the return air sensor, which may be located in the ceiling plenum.

The likely cleanliness of the air should be considered when selecting sensors.

Sensors representing zone temperature should be offset to account for heat gains, e.g. space temperature stratification, or if light fixtures are used as the return air path.

Sensors should only be used in return air ducts where air is continuously extracted.

Capillary sensors with probes
The device head must be higher than the sensor probe.

The sensor probe should be tilted downwards.

The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed.

The sensor element must always point downwards. The capillary should not form a U-shape.

The capillary should not be bent too tightly (radius of bend >50mm).

Averaging sensor (for use in ducts/AHU)
Allow a distance of at least 50 mm between any heat exchanger and the sensor.

The entire length of an averaging sensor must be fully inside the air-duct.

The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.

The sensor element should be installed in the air flow, downstream of the eliminator plate when air washers are used for humidification.

Frost protection thermostat
Leave a spare capillary loop of 20 cm to enable sensor testing outside the duct/unit.
The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space.

The capillary should be installed in the air flow, downstream of the first heating coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.

Room sensor
Sensors should be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.

The sensor should be located in an area representative of the entire control zone.

The sensor should be located away from heat sources, e.g. office IT equipment.

The sensor should be located in the area it controls.

Sensor locations near air currents generated by diffusers or openable windows, for example, should be avoided.

The sensor must not be exposed to direct solar radiation.

Avoid external walls except were unavoidable. Use insulated backplates.

Avoid recesses and alcoves.

The conduit entry points to the sensor wall box should be sealed where there is a risk of air from another zone flowing over the sensor element.

Do not install near or under lamps or above radiators.

Avoid chimney walls.

Do not install directly adjacent to doors.

Do not install behind curtains.

Do not fit to walls concealing hot-water pipes.

Outdoor air temperature sensors
Do not install on facades affected by significant rising heat, or facades which will be heated by solar radiation (fix sensors to a north-facing wall or use solar shields).

Avoid chimney walls and other walls subject to high internal heat gains.

Do not install under eaves.

Do not install above windows.

Do not install above ventilation extracts.

Ensure accessibility for inspection/verification.

An alternative to an external mounting is to locate the sensor in the AHU intake duct. This should ideally be upstream of the intake damper. Where this is not possible, it must be a suitable distance before recirculated air and mechanical devices to avoid their effects.

.02 **HUMIDITY SENSORS**

Humidity sensor/stat. – duct
The air velocity in the vicinity of the sensor must not exceed 10 m/s (a perforated steel plate cover can be used).

The sensor must not be located in dead-legs (super-saturation can occur in areas where there is no air flow).

A test hole must be provided downstream of the sensor, plugged off when not in use.

The sensor should be positioned beyond the spray distance of humidifiers.

Humidity sensor/stat. – room
The sensor should be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from the adjacent wall.

Avoid locations where the sensor will be exposed to direct solar radiation.

Avoid external walls except were unavoidable. Use insulated backplates.

Avoid alcoves and recesses.

Do not install near lamps or above radiators.

Do not fit to chimney walls.

Do not fit directly adjacent to doors.

.03 **PRESSURE SENSORS**

Pressure – general
Pressure sensors are affected by orientation. The pressure tubes must be provided with a binder point near the device head for test purposes.

The connection must be fitted with a bypass with a stop valve to avoid overload on one side when manipulating the sensors and to enable zero calibration. Isolating valves should also be fitted.

The sensor should be installed on a vibration-free surface or vibration-proof base.

The pressure-tapping point must not be located in turbulent air flow. Provide 6 x O/D upstream and 6 x O/D downstream of straight duct or pipe without obstructions.

Pressure – air
Probes for measuring static pressure should be installed parallel to the flow.

The differential pressure measuring tube should be correctly sized.

The tapping point should not be located where it will be affected by obstructions to the flow.

Pressure – liquids
Use a damping coil to avoid transferring vibrations (horizontal loops to avoid trapped air bubbles and condensate).

The device must always be installed in a location which is lower than the sensing point.

Do not measure at the top of a pipe (trapped air, bubbles) or at the bottom (dirt).

Pressure – gases
When measuring vapour gases, the device must always be installed in a location which is higher than the sensing point.

Measure at the top of the pipe to prevent condensate from entering the pressure tube.

.04 **FLOW VELOCITY/FLOW RATE SENSORS**

Differential pressure for flow monitoring – liquids
There should be no stop valves or balancing valves between the sensing points on the pipework.

Differential pressure for flow monitoring – air
Ensure a steadying zone upstream and downstream of the orifice plate/flow grid, etc.

The flow or differential pressure must not be monitored where there is a variable resistance such as a filter or fan, etc.

Velocity sensors
Sensors should be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity.

A single point sensor should be located at a distance from the centre of the duct equal to 0.25 x the duct radius.

Wilson flow grid
Averaging velocity sensors across the duct, e.g. Wilson flow grid or multi-point averaging pitot tubes, should be used where the minimum separation distance from a flow disruption is not available.

Ensure that the Wilson flow grid is sized correctly for each duct size.

.05 **INDOOR AIR QUALITY SENSORS**

CO2 and mixed-gas sensors - room mounted
Ensure that the sensor is located in a representative location, e.g. on an open wall 1.5 to 3 m above the floor.

Ensure that the sensor is not mounted in niches or bookshelves or behind curtains.

Ensure that the sensor is not located where people are continuously present (within 1 or 2 metres).

CO2 and mixed-gas sensors - duct mounted
Ensure that the sensor is located in the return air duct as close as possible to the room extract point(s).

Ensure that the sensor is located in the vertical position.

Ensure the correct orientation of the duct probe with respect to the airflow.

Ensure that the sensor is not installed in a vertical position with the head at the bottom.

.14 ACTUATORS

Securely mount actuators to rigid members, free from vibration or distortion in accordance with manufacturer's recommendations.

Select mounting positions to require minimum linkages, and to avoid angular drive to operating levers. Allow access for servicing and replacement.

Ensure that actuators and linkages for valves and dampers operate smoothly from fully open to fully closed, without binding and with adequate torque to overcome the resistance of the actuator mechanism and the flow and to provide the specified close off ratings.

Ensure that linkages are clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.

Fit actuators with visual position indication.

Ensure that there is sufficient space above the actuator so that it may be removed for testing or maintenance.

Include position feedback devices suitable for connection to the BEMS.

Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.

Ensure that actuators are electrically and mechanically protected from the effects of valve or damper seizure.

Use 24v actuators wherever possible. Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.

Ensure that, during commissioning, valve actuators are fitted in a fully closed/bypass position where they are being fitted to valves which push against a spring.

.15 VALVES

General

Ensure that valves have the correct authority without excessive pressure drop.

Ensure that valve bodies are suitable for the medium, the temperature and the pressure of the fluid system.

Ensure that valves will pass the required flow at a pressure drop within the maximum differential pressure rating of the valve.

Check for out-of-balance forces, particularly during operation of a three-port valve.

Where possible, ensure that valves are not installed with their spindles in the horizontal position.

If valves cannot be installed with their spindles in the vertical position, ensure that they are as near as possible to the vertical.

Ensure that valves are not installed with the actuator at the bottom.

Modulating valves

The following additional considerations apply for modulating valves:

Ensure system operating pressures, test pressures, pump heads and pressure drops through heat exchangers and associated pipework are known before control valves are selected.

Select valves to provide an authority of 0.3 to 0.5 for diverting applications and 0.5 for mixing applications.

Select valves with port characteristics appropriate for the intended function.

Ensure that all modulating control valves are selected for equal percentage or linear characteristics according to system type, to provide near linear characteristics between the valve position and heating/cooling power as delivered to the air or water-based system.

Ensure that the rangeability of the selected valves is large enough to provide stable control under low load conditions.

.01 **VALVE SIZING REQUIREMENTS**

All types of valves and applications

- Parameter - Body pressure rating
- Requirements - To exceed system test pressure.

All 2-port valves

- Parameter - Close-off pressure rating
- Requirements - To exceed pump or system full differential pressure.

All 3-port valves

- Parameters - Close-off pressure rating
- Requirements - To exceed out of balance pressures

All types of valves and applications

- Parameters - Maximum leakage coefficient
- Requirements - 0.05% KV.

2-port isolation valves

- Parameters - Pressure drop at full flow
- Requirements - Select at line size for minimal pressure drop.

2-port modulating valves

- Parameters - Pressure drop at full flow
- Requirements - Select KV value for pressure drop within an agreed range.

3-port modulating valves

- Parameters - Pressure drop at full flow
- Requirements - Select KV value for 30% - 50% authority against coil or circuit pressure drop.

Isolation valve

- Parameter - Characteristic.

Modulating valves (plant valves and zone re-heater coil valves)

- Parameters - Characteristic
- Requirements - Equal percentage.

Modulating valve (fan coil units)

- Parameters - Characteristic
- Requirements - Equal percentage (preferred) or linear.

Modulating valves (independently pumped mixing and injection circuits)

- Parameter - Characteristic
- Requirements - Linear.

.16 DAMPERS

Provide visual position indicators on all damper actuators installed so that they can be seen from the plant-room floor.

Ensure that damper characteristics are as linear as possible.

Ensure that modulating dampers are sized correctly to give adequate authority.

.17 COMMUNICATION NETWORKS - GENERAL

Ensure that all addressable control devices can be addressed over the communications network.

Ensure that the bandwidth and subsequent speed of communications is sufficient to meet the requirements of system

Ensure that no cross corruption of data occurs when the BEMS shares a communication network with other IT-based systems.

Ensure that permission has been given by the IT manager to connect BEMS components onto the IT network.

Ensure that network testing, identification and documentation comply with BS EN 50174.

Ensure that all network devices such as routers and bridges are compatible with the network and are capable of operating such that the required throughput of data is achieved.

.01 **COMMUNICATION NETWORKS - STRUCTURED CABLING**
Ensure that the selected BEMS components are suitable for operating on the structured cabling system.

Ensure that the selected BEMS topology (star wired, chained or bus-based) is appropriate for the structured cabling system.

Ensure that each addressable BEMS device can be addressed over the structured cabling system.

Where BEMS components are specified to be powered from the structured cabling system ensure that the power available is sufficient. Ensure that overheating of the structured cabling system will not occur.

Ensure that any changes to the structured cabling system are reflected in updated documentation.

.02 **COMMUNICATION NETWORKS - INTRANET AND INTERNET APPLICATIONS**
Ensure that the BEMS devices to be directly connected onto the Intranet/Internet are TCP/IP compatible.

Ensure that the data security requirements of BS ISO/IEC 27001 and BS ISO/IEC 17799 are met.

.03 **COMMUNICATION NETWORKS - MAINS-BOURNE SIGNALLING**
Comply with the requirements of BS EN 50065-1.

Provide the necessary equipment to ensure that there is no mutual interference between the signalling system of the electricity utility and mains-borne signalling of the BEMS.

.04 **COMMUNICATION NETWORKS - RADIO COMMUNICATIONS**

Ensure that the radio transmitter/receiver and the BEMS components are adequately powered.

Ensure that radio communications devices and associated BEMS components are easily accessible to allow the change of batteries.

Ensure that the attenuation of radio signals does not hinder effective data communications.

.18 INTEGRATION WITH FIRE DETECTION SYSTEMS - GENERAL

Ensure approval from the relevant Fire Prevention Officer or Building Control Officer.

Ensure that the requirements of BS 5839-1 are not compromised.

Ensure that the fire detection system can operate autonomously and will not be affected by any failure of the BEMS.

Ensure that the BEMS will not be affected by any failure of the fire detection system or fails safe, as appropriate.

Ensure that the loss of electrical power to the BEMS will have no adverse effects on the fire detection system.

Ensure that a full cause and effect testing programme is developed in conjunction with the fire alarm company.

Ensure that the integrated system is fully commissioned.

Ensure that the contractual responsibilities of the various parties responsible for the integrated system are fully defined.

.01 **INTEGRATION WITH FIRE SYSTEMS - INTEGRATION DETECTION FOR MONITORING**

Uni-directional systems

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

Provide building graphics/schematics on the BEMS operator workstation indicating the location of fire detector heads or zones, along with their respective status.

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

Ensure that any time delay in receiving fire alarm data at the operator workstation does not exceed 5secs.

.02 **INTEGRATION WITH FIRE DETECTION SYSTEMS - INTEGRATION FOR CONTROLS**
Provide fail-safe, hard-wired interlocks using volt-free contacts between the BEMS field controllers and items of plant listed.

Use volt-free contacts and 24v AC or DC interlocks.

Use relay logic and/or microprocessor-based logic.

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

.19 CONTROLS CIRCUITS

Supply Voltage
Ensure control circuits are 230 volt AC or DC or 230 volt AC single phase connected one single phase to neutral only.

Circuit Voltage
Where control circuits are taken outside the panel:

- Use 24 volt operating supply
- Use 230 volt operating supply.

CONTROL CIRCUITS TRANSFORMERS
Provide control circuit transformers to supply power at voltages to suit control components. Standard - use transformers in accordance with BS EN 61558-2-9, BS EN 61558-2-23 or BS EN 61558-1 and provide an external label of approved type and size.

Protection - Primary and secondary fuses.

.20 CONTROL PANELS

See clauses in the Standard Mechanical and Electrical Specifications issued separately.

.21 WORKMANSHIP

.01 **GENERAL**
Install pipeline control components in accordance with manufacturer's instructions.

Install ductline control components in accordance with DW 144 and manufacturer's instructions.

Install control components in accordance with manufacturer's recommendations, in positions indicated.

.02 **APPEARANCE**
Arrange, support and clip all control wiring, pneumatic tubes and capillaries to present a neat appearance, with other services and the building structure.

.03 **INSULATION**
Where control components are incorporated in insulated pipelines, ductlines or equipment, provide details for approval of method proposed to insulate component.

.04 **SUPPORTS**
Arrange supports for control components to ensure no strain is imposed on components.

.05 **ACCESS**
Arrange control components to ensure adequate access for operation and maintenance.

.06 **POWER OPERATED CONTROLS**
Install power operated controls in accordance with manufacturer's instructions and relevant standards.

.07 **ANCILLARIES**
Install ancillaries in accordance with manufacturer's instructions.

.08 **ENCLOSURES**
Install enclosures where indicated, providing space for access and maintenance.

.09 **BUILDING MANAGEMENT SYSTEM INSTALLATION**
Install commission and set to work building management system in accordance with the manufacturer's recommendations.

.10 **BUILDING MANAGEMENT SYSTEM CABLE INSTALLATION**
Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.

Label and record all monitoring cables in accordance with cable schedules and cable drawings.

.11 **BUILDING MANAGEMENT SYSTEM QUALITY CONTROL**
Handle, store and install equipment and components of the building management system in accordance with the manufacturer's recommendations.

Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.

Record all commissioning tests and site modifications to hardware or software, and revise operating and maintenance instructions accordingly.

.12 **CONTROL SYSTEM FUNCTION CHARTS**
Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval of function chart before design of system hardware or writing control software.

Function chart format.

Combined function chart/circuit diagram.

Function chart only.

.22 COMMISSIONING

Perform system commissioning in accordance with the Standard Mechanical and Electrical Specifications.

.23 DEMONSTRATION AND HANDOVER

.01 **WITNESSING REQUIREMENTS**
Ensure that the project supervisor's nominated representative implements the following witnessing requirements. Ensure that on-site commissioning staff facilitate the witnessing process.

Ensure that the BEMS hardware is installed in accordance with the specification.

Verify any operator software and associated graphics.

Witness completely the control of any main and/or critical items of plant along with a random sample of other points.

If less than 300 points, witness all points. Between 300 and 1,00 points witness 50% (minimum of 300 to be witnessed). If more than 1,000 points witness 20% (with a minimum of 500 points witnessed).

Reserve the right to witness 100% of the points if the failure rate is greater than 5%.

Witness a sample of specific functions, e.g. 10% of alarms and 10% of data logging.

Witness one of several identical items of plant in detail with the others witnessed on a random basis.

Verify the system security access.

Verify that all safety-related functions perform to that specified, e.g. plant shutdown on fire condition.

Verify all plant restarts according to that specified after building power failure and local power failure.

Witness all power meter data-points to ensure that they match the meters.

Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions.

Verify the handover of all operating manuals and system documentation.

Verify the handover of backup copies of software.

Verify the completion of any specified system operator training.

.02 **OPERATOR TRAINING**

Ensure that training is completed before the BEMS is handed over.

Ensure that each trained operator signs a training acceptance certificate(s).

Provide training off-site at the BEMS suppliers training facility. Complement this off-site training with 'hands on' on-site training.

Provide appropriate reference and training manuals for the operator.

Provide operator training for one or more of the following levels of operator.

Basic operator

Ensure that the operator is trained to:

- Call up and viewpoint-data from plant schematics and/or points lists
- Acknowledge system alarms
- View trend logs.

Intermediate operator

In addition to the requirements for a Basic operator, ensure that the operator is trained to make basic alterations to the BEMS including changes to:

- Time and occupancy programmes
- Control set-points
- Setting up trend logs
- Setting up alarm routines.

Ensure that the operator is also trained for testing and routine inspection of sensors and actuators.

Advanced operator

In addition to the requirements for an intermediate operator, ensure that the operator is trained to:

- Add or change graphics/schematics
- Change control strategies
- Add analogue and digital inputs/outputs to the system
- Back-up the system and archive logged data
- Re-load system software/configuration details
- Add/modify passwords/monitor system security.

.24 OPERATION AND MAINTENANCE MANUALS

Ensure that an initial draft of the O&M manual is submitted for approval prior to commissioning.

Ensure that the O&M documentation is produced as the work proceeds and is updated when necessary.

Ensure that this work commences at the start of the contract and is added to/updated as the contract progresses.

Ensure that approved final copies of the O&M manuals are provided at handover.

Ensure that the O&M manual is properly indexed. Ensure that terminology and references are consistent with the physical identification of component parts.

Ensure that the O&M manual includes the following and is included in the site health and safety file:

- A written description of plant operation
- Control strategy/logic diagrams recording the final version of configuration software installed at handover
- Details of system application software configuration
- A points list including hard and soft-points (all points should have a unique mnemonic)
- A description of user adjustable points
- Commissioning record details
- Detailed data sheets for all control components and equipment
- Wiring circuit details including origin, route and destination of each cable
- Basic security access to the system
- Comprehensive instructions for switching on, operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions
- Instructions for any precautionary measures necessary
- Instructions for the routine operation of the control system including simple day-to-day guidance for those operating the control system with limited technical skill
- Instructions for servicing and system upkeep
- A provision for update and modification.

Ensure that the O&M manual includes comprehensive system operating instructions.

.25 SOFTWARE

Ensure that a copy of the configuration software is held both on and off-site.

Ensure that, as alterations are made to the configuration software, all previous versions of the software are archived.

Ensure that changes made to the software are recorded in the O&M manual, along with the reasons why changes were made.

Ensure that all passwords are provided at handover.

.26 POST-HANDOVER CHECKS

Ensure that the following post-handover checks are performed:

- global level checks
- internal air temperature
- relative humidity
- ventilation
- energy consumption (ensure that the pulse-input counters match the meters).

Check that each of the above meets the specified requirements.

System level checks

Control strategies. Check that any suspect control strategies are appropriate for the intended application. Check that the suspect control strategy has been implemented and commissioned correctly. Check that the control strategy is still appropriate for the intended use.

Network communications. Check that all relevant field controllers communicate properly. Check for correct sharing between controllers of relevant data and correct inter-controller operation.

Control set-points. Check that the set-points in question are correct and appropriate for the actual operating conditions.

Control loop settings. Check that the control loop settings result in accurate and stable control. Check that all self-learnt characteristics are valid.

Control zones. Check that the control zones are appropriate.

Occupant controls. Check that occupant controls work correctly.

Sub-system/component level checks

Sensors. Check the accuracy and location of any suspect sensors.

Actuators. Check that any suspect actuators operate correctly.

Dampers and valves. Check that any suspect dampers and valves are not jammed and that they operate as intended.

4. PARTICULAR SPECIFICATION

.01 GENERAL

.01 The Mechanical Contractor shall be responsible for the development of the design, procurement, installation and coordination, sizing checks and agreement on the location of any necessary commissioning valves required, coordination, preparation of working drawings, supply, delivery, detailed on site co-ordination, installation, testing, commissioning and putting to work all of the systems described in this document.

Any drawings and scopes provided with this tender are to be checked and confirmed by the Mechanical Contractor. The Mechanical Contractor shall bring to the attention of the Services Consultant any discrepancies, anomalies or errors that may reasonably be found within the tender period, so that any necessary alterations may be included within the tender sum.

The Mechanical Contractor shall be responsible for the preparation of all builder's work information necessary for the installation of those services that they install, and for the preparation of drawings for approval of wiring, control panels, ductwork and any other item requiring site dimensions or specialist manufacture.

On completion of the works, the Mechanical Contractor shall be responsible for instructing the Client in the full use of the services that they have installed, and for producing a complete set of Record Drawings, Operating Instructions and Maintenance Manuals which shall be approved by the Services Consultant before issue to the Client).

Should the Mechanical Contractor require additional information to complete their design development and installation, they shall notify the Services Consultant in reasonable time for this to be produced in sufficient time to meet the installation programme. No delays for late receipt of design information will be accepted if the Mechanical Contractor fails to allow sufficient time for this operation.

The Mechanical Contractor shall be responsible for liaising with other trades as to the sequence of works to prevent any delay to the programme which may be caused by such a lack of understanding of the complete installation.

The Mechanical Contractor will be working for the Main Contractor, who will be providing General Attendance for all other parties on site. The Main Contractor will also be responsible for site safety, site security and temporary lighting.

All other necessary Specialist attendance shall be provided by the Mechanical Contractor.

Design and installations to be provided by the Mechanical Contractor are as follows:

- New incoming mains gas supply,
- New gas distribution system
- New gas boiler plant and LTHW distribution systems,
- New underfloor heating systems,
- Primary LTHW heating to new HWS Calorifiers,
- Passive ventilation systems,
- Mechanical ventilation systems
- New incoming mains water supply,
- New mains water distribution system,
- New domestic hot water generation and distribution system,
- Thermal insulation,
- New internal above ground drainage systems,
- New control systems and electrical wiring,

- Building Energy Managements System,
- Electrical works in connection,
- All necessary flushing, cleaning and water treatment,
- Testing and commissioning,
- Handover
- Record Documentation,
- 12-month warranty.

.02 MECHANICAL WORKS ASSOCIATED

.01 LTHW Heating System

.02 **LTHW Heating system**
The heating plant shall be located in the roof plantroom.

The system will comprise:
- 3No wall mounted gas fired boilers and individual boiler shunt pumps
- Dosing Pot
- Pressurisation Unit and Expansion Vessel
- LTHW AHU Secondary Pump Set
- Underfloor LTHW heating system Pump Set
- LTHW DHWS Primary Pump Set

Gas Fired Boilers
3No Remeha Pro Quinta 65 nominal 61 kW gas fired boilers with inline 3 boiler cascade unit.

The cascade unit is to come complete with all necessary safety valves/isolation and individual boiler shunt pumps and will operate at 70/50°C. each pump will be rated at 0.74 litres/sec.

New concentric flues to be taken from each boiler through the roof and discharge with a suitable terminal (as provided by the boiler manufacturer).

LTHW Pumps
The Mechanical Contractor is to supply, install and commission the following new LTHW pumps:

REF	SYSTEM	DUTY	MODEL	MANF
P4/5	DHWS LTHW Primary Pump Set	0.4litres/sec @ 50 kPa	MAGNA3 D 32-100F	Grundfos
P6/7	Underfloor LTHW Primary LTHW Pump Set	0.7 litres/sec @ 150 kPa	MAGNA3 D 40-150F	Grundfos
P8/9	AHU Secondary LTHW Pump Set	1.15 litres/sec @ 100 kPa	MAGNA3 D 32-120F	Grundfos
P10	DHWS Secondary Return Pump		ECOWATT 1	SMEDGUARD

LTHW Pressurisation Unit and Expansion Vessel (PU01)
Supply and install within the roof Plant Room, in the general position shown on the drawings, a pressurisation unit and associated expansion vessel complete with all necessary controls and safety devices

LTHW PRESSURISATION SET EQUIPMENT SCHEDULE		
System	LTHW	
Flow Temp Range	85°C	
Total Boiler Capacity (Kw)	165 kW	
System Capacity	By Contractor	
Static Head	13m	
Cold Fill Pressure	2.1 bar	
Final Working Pressure	3.2 bar	
No: of Pumps	2	Duty and Standby
Break Tank Size	18 litres	
Power Supply	230V/1Ph/50Hz	
Start Type	DOL	
Model	MP32-E Minipack	
Control Panel • Automatic controls & BEMS; • 2 line intelligent display showing system pressure and status; • visual and audible indication of fault warnings and alarms; • pump run and trip indication and hand/off/auto switches on fascia; • fascia keypad for viewing and setting parameters on site; • automatic cut-out and reset for low water level in break tank; • automatic alternation of duty pump; • interlocked door isolator; • BEMS outputs; • serial communications port for RS232 or RS422/485.		
Manufacturer and Supplier	AGM Plc AGM House, London Road, Copford, Colchester, Essex, CO6 1GT TEL: 01206 215100 Email: Hannah Dey <hld@aqpm.co.uk>	

LTHW PRESSURISTION UNIT EXPANSION VESSEL		
System	LTHW	
Vessel Size	By Contractor	
Max Working Press	6 bar	
Manufacturer and Supplier	AGM Plc AGM House, London Road, Copford, Colchester, Essex, CO6 1GT TEL: 01206 215100 Email: Hannah Dey <hld@aqpm.co.uk>	

The Mechanical Contractor is to make provision for all necessary isolation, non-return and commissioning valves, quick fill pipework connection and disconnecting hose, drain cocks and automatic venting valves, whether shown or not, as required by CIBSE and BSRIA codes.

A 5 litre dosing pot is to be provided.

The system is to be cleaned, flushed, treated and commissioned, in accordance with the requirements of the boiler manufacturer's requirements and CIBSE/BSRIA codes

Pipework
All LTHW pipework is to be Black Mild Steel – Heavy Weight or Carbon Steel Tube if above 150mm diameter.

The Mechanical Contractor is to make due allowance for expansion within the design of the pipework support system.

Commissioning Valves
The LTHW system shall have commissioning valves installed in the positions shown on the schematics and as needed to balance the systems. These shall be installed in accordance with the manufacturer's installation instructions.

The valves shall be as made by BOSS and be of the Venturi FODRV Type, the contractor shall select the individual valve on the basis of the following criteria depending on the size.

Ultra Low Flow signal 1 – 4.7 kPa
Low, Standard and High Flow 10 – 60 kPa

Noise and Vibration Isolation
Transmission of noise and vibration from plant, equipment and distribution infrastructure shall be prevented. All fans, pumps, booster sets, and any other items of noise and vibration producing equipment shall be attenuated to ensure design internal and external noise levels are not exceeded. All fans and pumps shall be mounted on vibration isolating mountings.

Insulation
All pipework and valves are to be thermally insulated and any external insulation weather proofed and mechanically protected to avoid damage.

Identification
All pipework and valves are to be identified.

System schematic and valve chart to be installed in the plantroom.

.03 **Under-floor Heating System**
The building shall be provided with an under-floor heating system sized to give the background indoor design temperatures, detailed below.

The building winter indoor design operative temperature for the different parts of the property are proposed as follows:

Worship Area	Winter 21°C
Entrance/Foyer	Winter 21°C
Kitchen	Winter 21°C
Staff Room	Winter 21°C
Toilets/Baby Change	Winter 21°C
Church Hall	Winter 21°C
Nursery	Winter 21°C
Offices/Reprographics	Winter 21°C
Prayer Room	Winter 21°C

Tea Point/Kitchenette	Winter 21°C
Crèche	Winter 21°C
Vestry	Winter 21°C

These are based on external design conditions of winter, -4°C db and -4°C wb.

See drawing for details of each Zone load.

The under-floor system is to be designed, sized and installed by a UFH Specialist Contractor (Multibeton or approved equal) with manifolds provided in the locations shown on the drawings.

Note that the LTHW water temperature at the point of connection to the under-floor system is 80°C. The UFH Specialist Contractor is to size their system with the necessary controls to ensure that their system can either operate at this temperature or be provided with the necessary controls/ pumping arrangement to avoid excessive temperatures being imposed on the under-floor pipework.

The Mechanical Contractor shall install a 3-port diverting valve as shown in Detail 'A' on the drawings and this is to be controlled in tandem with the manifold pump/valve so that when a manifold shuts down the diverting valve will open.

The Mechanical Contractor shall allow for the UFH Specialist Contractor to supply and install the under-floor heating systems for the areas, as indicated on the drawings.

The system shall comprise 17mm dia Europipe installed in the locations shown on the drawings, and fed from manifolds sited in the locations shown on the drawings.

The manifolds shall be contained within standard steel cabinets and shall incorporate isolating and regulating valves on main flow and return connections, as well as flow rate indicators on each pipe circuit.

Each of the areas shall be designated as a separate circuit and shall have a room sensor controlling that circuit.

The manifolds shall be provided with all necessary controls, mixing valve, pump, balancing/commissioning and isolation valves, all to be provided by the UFH Specialist Contractor.

The room sensors and motorised valves shall be installed by the Mechanical Contractor. The Mechanical Contractor shall also provide cabling between sensor and manifold and make the final connections, as described in the Specification.

Standard clip rail pipe supports shall be used to suit the room layout and output, and screed shall be applied on completion by the UFH Specialist Contractor, after hydraulic testing of the pipework. The whole of the under-floor heating system shall be subject to the provision of a 30 year warrantee.

See drawings for details of the UFH Zone layout.

.04 ***Main Entrance Door Heater (DH01)***

An overhead door heater is to be provided fed from the CT Heating Circuit (pump P6/7), the door heater shall be supplied by JS Air Curtains, RUND 2000 Vertical Type B rated at 21 kW nominally water flow conditions 70/50°C. Air ON 15°C (or approved equal).

The door heater is to be controlled by means of JS Air “Clever Controller” and a 3-port valve with the facility to interface with the BEMS.

.02 Natural Gas

.01 **Incoming Natural Gas Supply**

The Mechanical Contractor is to liaise with SGN to disconnect and remove the meter and the existing incoming supply, and to obtain a new supply with the meter located externally on a concrete base as shown on the drawings.

From this meter a new MDPE underground main is to be run by the Mechanical Contractor to external wall of the building (as shown on the drawing) the main is to change to steel and enter the building and rise to feed the roof mounted boilers and the ground floor tea point and 1st floor kitchen (as shown on the drawings).

A manual AECV shall be installed with a purge point as the service passes through the external wall into the building.

The Mechanical Contractor shall be responsible for the supply and installation of a complete and pressure-tested external and internal distribution system to serve multiple points, as shown on the drawings.

.02 **Natural gas Distribution**

The Mechanical Contractor shall be responsible for the supply and installation of a complete new and pressure-tested internal distribution system.

The Mechanical Contractor shall install purge points as necessary.

An automatic solenoid valve shall be fitted in the boiler room and shall be interlinked with new flame detectors above each boiler and a new emergency knock-off button. or by the fire alarm system.

An automatic solenoid valve shall be fitted in the 1st floor kitchen, linked to a gas guard system (including a link to the Fire Alarm system and kitchen extract ventilation).

The Mechanical Contractor shall at this stage allow for connecting of equipment within the vicinity of the extract hood. Connection to equipment shall be in rigid pipework, each item of equipment shall be individually valved.

Pipework up to 50mm diameter is to be run in TRACPIPE, above this pipework is to be run in either Black Mild Steel Tube Heavy Weight or Carbon Steel Tube if above 150mm diameter.

All steel pipework shall be pre-primed and painted yellow ochre.

All pipework to be installed in accordance with the latest requirements of IGEM Regulations.

.03 Domestic Hot and Cold Water

.01 **Incoming Mains Water Supply**

The Mechanical Contractor shall be responsible for the supply and installation of a complete and pressure-tested external and internal distribution system to serve multiple points, as shown on the drawings.

The Mechanical Contractor is to liaise with Southern Water to disconnect and remove the existing incoming supply, and to obtain a new supply with the meter located at the boundary of the site (see drawing).

From this meter a new underground main is to be run by the Mechanical Contractor into the where it is to change to UPONOR MLC.

All external water mains will be run in Blue MDPE (Barrier) pipework.

Water Leak Detection System
A leak detection system on the incoming mains cold water is to be provided at the point of entry to the building

This shall comprise:

LEAK DETECTION SYSTEM SCHEDULE	
Model	Aquitron AT – WM 67/75 (detection)
Solenoid Valve	Aquitron Soleniod Valve N/C 6V DN65 (shut-off valve)
Control Panel	
Size	145 x 85 x 50mm
Power	12Vdc 250mA (Transformer Included)
BEMS Volt Free Relay	24Vdc, 1 amp
Solenoid valve	230Vac controlled through a separate relay unit
Manufacturer and Supplier	Aquilar Ltd Weights & Measures House, 20 Barttelot Road, Horsham, West Sussex, RH12 1DQ TEL: 01403 216100 Email: info@aquilar.co.uk

Future Cold Water Connection for Cold Water Booster Set
Allowance will be made to the possible provision at a later date of a cold water booster set, the position of this will be as shown on the drawings.

Water Conditioner
Supply and install at the point of entry to the building a magnetic physical water conditioner on the incoming water supply.

The unit shall be a 'Hydromag' unit, as manufactured by Hydrotec (UK) Ltd, size DN50mm, installed as per the manufacturer's instructions.

The unit shall be supplied complete with a control panel fixed to the wall adjacent to the unit, (also supplied by Hydrotec [UK] Ltd), and shall be powered via a local supply provided by others (final wiring by the Mechanical Contractor), with volt free connection to be wired back to the BEMS, also for fault alarm notification.

.02 **Cold Water Service**
All MWS pipework shall be run in UPONOR MLC, fully insulated and vapour sealed.

Generally, all pipework shall be routed in ceiling voids and ducts where provided, and no exposed pipework will be acceptable unless by prior agreement with the Architect.

The complete cold water installation shall be in accordance with BS 8558:2015, PD855468, the Water Authority Regulations and the latest BS 6700.

Ballofix type valves shall be fitted on the supply to each outlet.

Flow limiting devices will be provided on all taps.

Drain cocks to be provided at low points.

External Taps on roof terraces and adjacent to the car parking area

There will be three external taps provided one in each of the terraces and one to serve the car parking area each with a double check valve.

The location of these can be found on the drawings.

All pipework is to be fully insulated.

Male WC Areas
Urinals to have individual direct flush IR valves, as manufactured and supplied by Cisternismer Ltd.

.03 **Hot Water Service**
Central DHWS indirect calorifier system will be installed in the roof plantroom.

There will be 2 No calorifiers (C1 and C2) each will be a Megaflow Eco 300i, with PRV/Safety Valve, expansion vessel, hot water return circulation pump (P10) and NRVs.

Primary LTHW will be supplied to the calorifier by Pump Set P4/5 via 3-port control valves (MV01 & 02) which will be controlled by the individual calorifier thermostats.

Ballofix type valves shall be fitted on the supply to each outlet.

Flow limiting devices will be provided on all taps.

Drain cocks to be provided at low points.

This will serve all sinks and basins.

TMV3 approved blending valves shall be installed on all basins, as noted on the drawings, to provide blended water.

The Mechanical Contractor shall carry out the mains unvented installation, in accordance with the latest G3 regulations (2009).

All pipework shall be run in UPONOR MLC, fully insulated.

The complete hot water installation shall be in accordance with BS 8558:2015, PD855468, the Water Authority Regulations and the latest BS 6700.

.04 Ventilation

GENERAL NOTE
All ductwork where passing through any fire rated wall are to have fire dampers, these are to be of the required size to suit duct sizes and are to be the Type 'ES' Fire/Smoke Dampers as manufactured and supplied by Actionair Ltd.

.01 **Natural ventilations Systems**

Worship Area
Supply and install, packaged active turrets/motorised damper and internal perforated grille units as manufactured by:

TEK Ltd.,
14 Seeley's Road,
Greet, Birmingham
B11 2LQ
Tel: 0121 7665005

In the positions indicated on the architect's drawings, and in accordance with the schedule below. Method of installation as detailed on architect's drawings.

Specification:
4No nominally 1200 x 1200 x 1200 H active packaged units comprising:

External Louvres EL75 with insect mesh and mitred corners powder coated Standard RAL colour TBC by architect prior to manufacture.

Motorised Dampers in each of the 4No units controlled by means of the averaging the carbon dioxide (C02) and temperature sensors specified in the controls section.

Actuators to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

Rain detection system to be provided using an external wind/rain sensor.

Solar Boost Fans

Internal finish – 50% free-area perforated grille powder coated Standard RAL colour TBC by architect prior to manufacture. Sections over the actuators to be removable for maintenance.

BEMS control system to be by System Five Controls Ltd.

Second Floor Nursery
Supply and install, packaged active turrets/motorised damper and internal perforated grille units as manufactured by:

TEK Ltd.,
14 Seeley's Road,
Greet, Birmingham
B11 2LQ
Tel: 0121 7665005

In the positions indicated on the architect's drawings, and in accordance with the schedule below. Method of installation as detailed on architect's drawings.

Specification:

1No nominally 1100 x 1100 x 1100 H active packaged units comprising:

External Louvres EL75 with insect mesh and mitred corners powder coated Standard RAL colour TBC by architect prior to manufacture.

Motorised Dampers in each of the 4No units controlled by means of the averaging C02 and temperature sensors specified in the controls section.

Actuators to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

Rain detection system to be provided using an external wind/rain sensor.

Solar Boost Fan

Internal finish – 50% free-area perforated grille powder coated Standard RAL colour TBC by architect prior to manufacture. Sections over the actuators to be removable for maintenance.

In addition, manually openable roof light and windows are provided which can be used to supplement the above should the occupants wish.

BEMS control system to be by System Five Controls Ltd.

Second Floor Nursery/Meeting Room
Supply and install, packaged active turrets/motorised damper and internal perforated grille units as manufactured by:

TEK Ltd.,
14 Seeley's Road,
Greet, Birmingham
B11 2LQ
Tel: 0121 7665005

In the positions indicated on the architect's drawings, and in accordance with the schedule below. Method of installation as detailed on architect's drawings.

Specification:

1No nominally 1100 x 1100 x 1100 H active packaged units comprising:

External Louvres EL75 with insect mesh and mitred corners powder coated Standard RAL colour TBC by architect prior to manufacture.

Motorised Dampers in each of the 4No units controlled by means of the averaging C02 and temperature sensors specified in the controls section.

Actuators to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

Rain detection system to be provided using an external wind/rain sensor.

Solar Boost Fan

Internal finish – 50% free-area perforated grille powder coated Standard RAL colour TBC by architect prior to manufacture. Sections over the actuators to be removable for maintenance.

In addition, manually openable roof light and windows are provided which can be used to supplement the above should the occupants wish.

BEMS control system to be by System Five Controls Ltd.

First and Second Floor Prayer Rooms
Ventilated via openable windows.

.02 **Mechanical ventilation Systems**

First Floor Church Hall (AHU 01)
The Church Hall will be ventilated by means of a package AHU controlled via room CO_2 and Temperature sensors.

Air will be supplied via low velocity ductwork to a number of ceiling diffusers within the space.

Return air is via ceiling grilles using the void as a return plenum and then via ductwork back to the AHU.

Unit Ref	**AHU 01**	**CHURCH HALL**		
SUPPLY SECTION				
Inlet		Weather louvre c/w bird guard		
Inlet Damper		Open/Closed		
Attenuator	Splitter	1200mm	Long	
Frost Coil	Medium	LTHW		
	Duty (kW)	21.67		
	Air ON/OFF (°C)	-5/12		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	0.26		
	Coil PD (kPa)	10		
Pre Filter		G4 - Panel		
Main Filter		F7 - Bag		
Heat Recovery				
	Type	Thermal Wheel		
Cooing Coil - Heat Pump	Medium	DX R410A		
	Duty (kW)	38.01		
	Air ON (°C/%RH)	29.0/50		
	Air OFF (°C/%RH)	12.0/94		
Re-Heat Coil	Medium	LTHW		
	Duty (kW)	20.72		
	Air ON/OFF (°C)	12.0/27.3		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	0.25		
	Coil PD (kPa)	5		
Fan				
	Air Volume (m^3/sec)	1.1		
	Ext. Pressure (Pa)	225		
	Motor Rating (kW)	2.2	Inverter controlled	
	Electrical Supply	400/50/3		
Attenuator	Splitter	900mm	Long	
Outlet		Full open aluminium profile		
EXTRACT SECTION				
Inlet		Full open aluminium profile		
Inlet Damper		Open/Shut		
Attenuator	Splitter	900mm	Long	
Pre-Filter		G4 - Panel		
Heat Recovery	Type	Thermal Wheel		
	Return Air (°C)	19		
Fan				
	Air Volume (m^3/sec)	1.0		
	Ext. Pressure (Pa)	250		

	Motor Rating (kW)	1.1	Inverter controlled	
	Electrical Supply	400/50/3		
Attenuator	Splitter	900mm	Long	
Outlet	Fully open Aluminium profile			
Overall Unit Dimensions	Length (mm)	Width (mm)	Height (mm)	Base (mm)
	6200	1200	1800	100
NOTES 50mm aluminium penta-post with 45mm double skin panels Inner skins 1.6mm galvanised steel with 60kg/m3 dense infill 100mm folded galvanised steel base frame Access doors are of the lift off type All filters are side withdrawable AHU to be suitable for external use Flat roof and weather louvres fitted Fans mounted in the airstream and isolated via rubber a/v mounts and flexible connector Fans are plug type IE3 motors and inverter controlled. Fans to comply with ErP regulations Unit to be supplied in sections for assembly on site - Mechanical Contractor to liaise with manufacturer to ensure that units can be installed on site				
Manufacturer				
	Imofa UK Ltd., (or approved equal) New Coach House, 21 Grange Way, Colchester, Essex, CO2 8HF. Tel: (01206) 505909 Fax: (01206) 794095			

Intake, exhaust, return and supply side attenuators to be provided as part of the AHU.

General Building System (AHU 02)
This unit will supply fresh air to the Ground Floor Lobby, 1st Floor Lobby and the 2nd Floor corridor.

The unit will have inverter control and to ramp up/down depending on the carbon dioxide (CO2) level within the Ground Floor lobby.

Air will be supplied via low velocity ductwork to a number of ceiling diffusers within the various rooms.

A percentage of the supply air is returned via ceiling grilles using the Ground Floor lobby void as a return plenum and then via ductwork back to the AHU.

The remainder of the air is extracted via the various extract systems serving the WCs and other ancillary areas on the 1st and 2nd Floors.

Unit Ref	**AHU 02**	**GENERAL BUILDING SYSTEM**		
SUPPLY SECTION				
Inlet		Weather louvre c/w bird guard		
Inlet Damper		Open/Closed		
Attenuator	Splitter	1200mm		
Frost Coil				
	Duty (kW)	6.21		
	Air ON/OFF (°C)	-5/5		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	.08		
	Coil PD (kPa)	3		

Pre Filter		G4 - Panel		
Main Filter		F7 - Bag		
Heat Recovery				
	Type	Thermal Wheel		
	Supply Air IN/OUT (°C)	5/11.4		
Re-Heat Coil				
	Duty (kW)	13.79		
	Air ON/OFF (°C)	5/25		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	0.17		
	Coil PD (kPa)	14		
Fan				
	Air Volume (m^3/sec)	0.56		
	Ext. Pressure (Pa)	175		
	Motor Rating (kW)	0.75	Inverter controlled	
	Electrical Supply	400/50/3		
Attenuator	Splitter	900mm	Long	
Outlet		Full open aluminium profile		
EXTRACT SECTION				
Inlet		Full open aluminium profile		
Inlet Damper		Open/Shut		
Attenuator	Splitter	900mm	Long	
Pre-Filter		G4 - Panel		
Heat Recovery	Type	Thermal Wheel		
	Return Air (°C)	19		
Fan				
	Air Volume (m^3/sec)	0.26		
	Ext. Pressure (Pa)	175		
	Motor Rating (kW)	0.75	Inverter controlled	
	Electrical Supply	400/50/3		
Attenuator	Splitter	900mm	Long	
Outlet				
Overall Unit Dimensions	Length (mm)	Width (mm)	Height (mm)	Base (mm)
	5600	950	1200	100

NOTES

50mm aluminium penta-post with 45mm double skin panels
Inner skins 1.6mm galvanised steel with 60kg/m3 dense infill
100mm folded galvanised steel base frame
Access doors are of the lift off type
All filters are side withdrawable
AHU to be suitable for external use
Flat roof and weather louvres fitted
Fans mounted in the airstream and isolated via rubber a/v mounts and flexible connector
Fans are plug type IE3 motors and inverter controlled.
Fans to comply with ErP regulations
Unit to be supplied in sections for assembly on site - Mechanical Contractor to liaise with manufacturer to ensure that units can be installed on site

Manufacturer	
	Imofa UK Ltd., (or approved equal), New Coach House, 21 Grange Way, Colchester, Essex, CO2 8HF. Tel: (01206) 505909 Fax: (01206) 794095

Intake, exhaust, return and supply side attenuators to be provided as part of the AHU.

First Floor Kitchen (AHU 03)

The kitchen will be provided with a supply and extract system which shall feed the kitchen hood (the hood will be supplied and installed by the kitchen fit-out Mechanical Contractor).

Unit Ref	**AHU 03**	**KITCHEN SUPPLY**		
SUPPLY SECTION				
Inlet		Weather louvre c/w bird guard		
Inlet Damper		Open/Closed		
Attenuator	Splitter	1200mm	Long	
Frost Coil				
	Duty (kW)	4.43		
	Air ON/OFF (°C)	-5/5		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	0.05		
	Coil PD (kPa)	1		
Pre Filter		G4 - Panel		
Main Filter		F7 - Bag		
Re-Heat Coil				
	Duty (kW)	7.39		
	Air ON/OFF (°C)	5/20		
	LTHW ON/OFF (°C)	70/50		
	LTHW Flow (l/sec)	0.09		
	Coil PD (kPa)	5		
Fan				
	Air Volume (m^3/sec)	0.4		
	Ext. Pressure (Pa)	300		
	Motor Rating (kW)	0.75	Inverter controlled	
	Electrical Supply	400/50/3		
Attenuator	Splitter	900mm	Long	
Outlet		Full open aluminium profile		
Overall Unit Dimensions	Length (mm)	Width (mm)	Height (mm)	Base (mm)
	5200	700	700	100

NOTES

50mm aluminium penta-post with 45mm double skin panels
Inner skins 1.6mm galvanised steel with 60kg/m3 dense infill
100mm folded galvanised steel base frame
Access doors are of the lift off type
All filters are side withdrawable
AHU to be suitable for external use
Flat roof and weather louvres fitted
Fans mounted in the airstream and isolated via rubber a/v mounts and flexible connector
Fans are plug type IE3 motors and inverter controlled.
Fans TO comply with ErP regulations
Unit to be supplied in sections for assembly on site - Mechanical Contractor to liaise with manufacturer to ensure that units can be installed on site

Manufacturer				
	Imofa UK Ltd., (or approved equal). New Coach House, 21 Grange Way, Colchester, Essex, CO2 8HF Tel: (01206) 505909 Fax: (01206) 794095			

Intake, exhaust, return and supply side attenuators to be provided as part of the AHU and be suitable for a kitchen ventilation system.

First Floor Kitchen Extract fan (KEF 01)
The Kitchen Hood Extract fan with variable speed control (inverter), complete with cleanable intake and discharge attenuators on the intake and discharge sides.

Extract ductwork to be 1 hour fire rated (Durasteel).

The supply AHU fan and the extract fan shall be set up to track each other in terms of volume flow.

The minimum setting (when gas is not being used) shall be variable between 30% and full volume, and the extract fan shall be used as the set point for the supply to track.

In the event that any gas appliance is turned on, the extract shall immediately ramp up to 100% of duty.

In the event that there is a lack of flow the gas proving system shall shut off the gas solenoid valve and raise an alarm on the BEMS.

Unit Ref	**KEF 01**	**KITCHEN EXTRACT**		
Fan				
	Air Volume (m^3/sec)	0.46		
	Ext. Pressure (Pa)	250		
	Motor Rating (kW)	0.35	Inverter controlled	
	Electrical Supply	400/50/3		
Overall Unit Dimensions	Length (mm)	Width (mm)	Height (mm)	Base (mm)
	500	500	500	100
Attenuators		Length (mm)	Width (mm)	Height (mm)
System Side	Duct Mounted Melinex Lined	1500	370	370
Exhaust	Duct Mounted Melinex Lined	1800	425	420
NOTES 30mm aluminium penta-post with 25mm double skin panels Inner skins 1.0mm galvanised steel with 60kg/m3 dense infill 100mm folded galvanised steel base frame Access doors are of the lift off type AHU to be suitable for external use Flat roof Fans mounted in the airstream and isolated via rubber a/v mounts and flexible connector Fans are plug type IE3 motors and inverter controlled. Fans TO comply with ErP regulations Unit to be supplied in sections for assembly on site - Mechanical Contractor to liaise with manufacturer to ensure that units can be installed on site				
Manufacturer				
	Imofa UK Ltd., (or approved equal) New Coach House, 21 Grange Way, Colchester, Essex, CO2 8HF. Tel: (01206) 505909 Fax: (01206) 794095			

Exhaust and return side attenuators to be provided lined with Melinex.

Ground Floor, 1st Floor and 2nd Floor Ancillary Areas
These shall be ventilated by means of NUAIRE type fans (or approved equal):

REF	SYSTEM	AIR VOL	MODEL
		(l/sec)	
EF 01	Ground Floor Tea Point	96	XS 12 CL/TS-TA12 with XS-MSC speed controller and roof terminal XS-RT12
EF 02	Ground Floor WC	15	OPUS 40T EP TWIN FAN
EF 03	1st Floor Reprographics		OPUS 40S EP
EF 04	1st Floor Vestry WC	18	OPUS 40T EP TWIN FAN
EF 05	1st Floor Male WC	55	MEVDC – ES G2 L
EF 06	1st Floor Female WC	50	MEVDC – ES G2 L
EF 07	1st Floor Disabled WC	20	OPUS 40T EP TWIN FAN
EF 08	1st Floor Flower Room	20	OPUS 40S EP
EF 09	2nd Floor Drinks Room	16	OPUS 40T EP
EF 10	2nd Floor Kitchenette	30	OPUS 60T EP TWIN FAN
EF 11	2nd Floor Baby Change	16	OPUS 40T EP TWIN FAN
EF 12	2nd Floor Children WC	40	MEVDC – ES G2 L
EF 13	2nd Floor Disabled WC	16	OPUS 40T EP TWIN FAN

The units will operate via individual PIR within the units and will run at trickle rate only entering boost when the PIR is activated, the override timer is to be initially set at 15 minutes over-run.

.03 **Smoke/Fire Damper System**
Fire/Smoke dampers are to be installed in ductwork in the locations shown on the drawings.

The dampers shall be as manufactured by Actionair and be the SmokeShield PTC Proportional Torque Control, CE Marked 'ES' Rated type Fire/Smoke Dampers.

The Control Mode shall have spring Fail-Safe Closed operation only, with Control Mode M6 230V.

The system shall have an Actionair addressable LNS4 control panel, interfaced with the fire alarm system and AHUs.

The panel shall be located at the main entrance next to the Fire Alarm Panel.

The Mechanical Contractor is to allow for provision of all necessary control and power wiring for the system and is to liaise with the Main Mechanical Contractor and Electrical Mechanical Contractor to ensure the installation is compatible.

Manufactured and Supplied by:

Actionair
South Street,
Whitstable,
Kent,
CT5 3DU

Tel: +44 (0)1227 276100
Email: sales@actionair.co.uk

Smoke/Fire Door Transfer Grilles
Door smoke/fire transfer grilles are to be installed in all FS30 and above doors, the grille types shall be as manufactured by Lorient UK type LV20S (size to suit door thickness) and to have the Lorient DCM control and monitoring system.

The Mechanical Contractor is to allow for provision of all necessary control and power wiring for the system and is to liaise with the Main Mechanical Contractor and Electrical Mechanical Contractor to ensure the installation is compatible.

Manufactured and Supplied by:

Lorient Polyproducts Ltd
Endeavour House
Fairfax Road
Heathfield Ind Estate
Newton Abbot
Devon T
Q12 6UD

Tel: 01626 834252
email: mktg@lorientuk.com

.04 **Noise Control**

Initial attenuator selections have been provided by QT Acoustics based on the requirements set out in the “Acoustic Design Specification” issued by Ian Sharland Ltd for the building and the external noise control.

The Mechanical Contractor shall be responsible for complying with all aspects of the “Performance” requirements of this specification and shall take the initial attenuator selections as a basis for developing and confirming that all plant and equipment and system designs meet these requirements.

The Mechanical Contractor is to liaise with Ian Sharland Ltd to ensure that the Noise Control requirements are met and to obtain their approval to the selections of attenuators and any other noise control equipment.

The Performance Design Specifications are:

Acoustics Documents:

Supplier of Noise Control Equipment
QT Acoustics Ltd.,
Whitecroft,
Prospect Road,
Ash Vale,
Surrey
GU12 5EL

MCA SERVICES CONSULTANTS LTD
8 NEWHOUSE BUSINESS CENTRE
OLD CRAWLEY ROAD, HORSHAM
WEST SUSSEX RH12 4RU
—
INFO@MCALTD.CO.UK
MCALTD.CO.UK
01293 851490

CERTIFICATE NUMBER 5745
ISO 9001, OHSAS 18001

REF	DESCRIPTION	MODEL	FLANGE	SPECIAL	WIDTH (mm)	HEIGHT (mm)	LEG 1 (mm)	LEG 2 (mm)	DIA (mm)	Insertion Loss - Octave-Band Centre Frequency (dB)								PD(Pa)	AIR FLOW (m^3/sec)	QUANTITY
										63	125	250	500	1K	2K	4K	8K			
ATT 1	AHU 1 Supply																			
ATT 2	AHU 1 Extract																			
ATT 3	AHU 1 Exhaust																			
ATT 4	AHU 1 FAI																			
ATT 5	AHU 2 Supply																			
ATT 6	AHU 2 Extract																			
ATT 7	AHU 2 FAI																			
ATT 8	AHU 2 Exhaust																			
ATT 9	KEF01 Extract																			
ATT 10	KEF01 Exhaust																			
CTA 1																				
CTA 1A																				
CTA 2																				
CTA 3																				
CTA 4																				
CTA 5																				

Table to be completed by the Mechanical Contractor as part of acoustic compliance aspects of the design and installation.

Supplier of Noise Control Equipment

QT Acoustics Ltd.,
Whitecroft,
Prospect Road,
Ash Vale,
Surrey
GU12 5EL

.05 **Vibration Control**

The Mechanical Contractor is responsible for complying with all aspects of the noise and vibration control from rotating plant in order to meet the *requirements set out in the "Acoustic Design Specification" issued by Ian Sharland Ltd for the building and the external noise control.*

The Mechanical Contractor is to liaise with Ian Sharland Ltd to ensure that the noise and vibration control requirements are met and to obtain their approval to the selections of attenuators and any other noise control equipment.

The Mechanical Contractor is to also provide details of the support requirements to the Architect and Structural Services Consultants for their approval.

Supplier of Vibration Control Equipment

Mason UK Ltd.,
Unit 6,
Abbey Business Park,
Monks Walk,
Farnham
GU9 8HT

.05 Above Ground Drainage

.01 **Sanitary Ware**

The Mechanical Contractor shall allow for the fixing of all sanitary ware and associated fittings, which will be supplied 'free issue' by others.

All costs associated with the installation of the sanitary ware shall be included by the Mechanical Contractor.

.02 **Soil and Wastes**

The Mechanical Contractor shall supply and install above-slab drainage pipework for the WCs, kitchen sinks etc., including all vertical soil and vent pipework, as shown.

SVP stacks shall be taken through the roof to vent.

The Mechanical Contractor shall assume that overflow pipes from WC cisterns shall be internal.

The installation shall comply with section H of the Building regulations, Statutory Authority Regulations and all relevant British Standards.

Condensate Drains/Pressure Relief Valve Discharges

The Mechanical Contractor is to allow for taking all drains from pressure relief valves and condensate drains AHU, Boilers and DHWS Calorifiers etc., to a point of discharge as recommended by the manufacturer of the respective item of equipment.

A direct connection from the condensate drain to a waste / soil stack or foul drain will not be permitted.

Each condensate drain shall discharge via an air-break tundish connected onto a HEPVO waste valve.

Any condensate drains from external roof mechanical plant (EXCEPT Boilers, flues or kitchen extract ducts) shall each have a connection from their drip tray to a common drainage run discharging onto roof areas via gutters, or floor gullies. The system shall be installed in copper tube to BS EN 1057: Part 1.

The first 2 metres of copper tube shall be insulated to prevent condensation forming on the outside of the pipe.

.06 Roof Plant/Pipework Support System

.01 The Mechanical Contractor shall allow for the provision of all necessary supports to plant and pipework etc., using the Big Foot System.

The structural engineer is to be provided with installation details for checking loads prior to any installation is commenced.

The system is to be as recommended by Big Foot Systems Ltd., for the specific application.

Contact Details

Big Foot Systems Ltd.,
Apex Way,
Hailsham,
East Sussex
BN27 3WA

Tel: 01323 844 355
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.07 Maintenance

.01 The Mechanical Contractor shall allow for the provision of 2 years maintenance cover within their return.

.07 BEMS AND CONTROLS

.01 **General**

A BEMS Contractor shall allow for the design, supply, installation and commissioning of the automatic control systems described and shall allow for carrying out all associated electrical wiring, both power and control, required to complete the works.

A Motor Control Panel (MCP) will be located in the Roof plantroom and will control and power all equipment except for the Ground Floor Tea point, Ground Floor Over Door Heater, 1st Floor Reprographics Room, 1st Floor Flower Room, WCs, Baby Change, 2nd Floor Drinks Area and 2nd Floor Kitchenette extract fans, the Natural Ventilation Systems and the underfloor heating manifolds which will be fed electrically via local spurs by the Electrical Contractor.

The panel will of form two construction and will have separate controls and power sections. It will be equipped with the latest IQ4 range of Trend controls and will feature a fascia mounted touchscreen to allow local interrogation and adjustment.

Hand / Off /Auto switches along with appropriate lamps to indicate plant conditions will be provided for all items controlled from the MCP.

Additionally, an alarm unit will be installed to the reception area. This will be engraved with the words Plant Alarm and will have a buzzer, mute button and lamp on it. This will be activated if a critical plant alarm occurs. The criteria defining what is a critical alarm shall be agreed prior to implementation with The Services Consultant.

Time schedules, optimum start & frost routines shall be employed for all plant directly controlled by the BEMS.

NOTE THE ELECTRICAL SUPPLY SIZE TO THE MCP WILL BE THREE-PHASE
IT IS THE BEMS CONTRACTORS RESPONSIBILITY TO CHECK WITH THE SERVICES CONSULTANT WHAT THE RATING OF THE SUPPLY IS AND THAT THIS IS ACCEPTABLE BEFORE SUBMITTING ANY PANEL DESIGNS FOR APPROVAL.

Option cost to be provided for remote access and for a head-end within the building.

All controls work will be undertaken by:

System Five Controls Ltd (or approved equal)
1st Floor, Vantage House
6-7 Claydons Lane
Rayleigh
Essex
SS6 7UP

01268-777475

The Mechanical Contractor shall also allow for the provision of the power supply to any control panel provided by the BEMS Controls Specialist.

The BEMS Contractor shall prepare wiring diagrams for the control systems and for the supplies to plant and equipment items and shall submit these to the Services Consultant prior to commencing any electrical work.

The BEMS Contractor shall include the supply and installation of any wall-mounted control panels and all equipment etc. necessary to achieve the controls operation described below.

Upon completion and commissioning of the system it shall be demonstrated to the Services Consultant to ensure their satisfaction, or otherwise, with it. Any defect noted shall be rectified at no cost.

Once the Services Consultant is satisfied with the system, the Client will be familiarised with the system and trained in its use.

The overall scope of work is the installation of a new control system to cater for the various systems being installed at the building.

The design should show how it incorporates the most up to date control routines and energy-saving techniques.

The control system shall be based on the latest Trend product, with allowance made for its future expansion, as required.

Where hardwired interlocks are specified then their action shall be mimicked in software to prevent unnecessary alarms being generated.

Frost and fabric protection routines will be programmed to ensure that the building is prevented from being damaged by frost or low temperatures. As with all other proposed control routines, the exact operation of this is to be agreed with the Services Consultant.

A space sensor will be installed in a location as neutral as possible within each zone and will be used for optimum start and fabric protection purposes.

.02 **Systems Descriptions**

The following sections describe each system and how it is anticipated to operate in the new scheme. This should be taken as a guide only and does not relieve the Mechanical Contractor of any of their responsibilities as described elsewhere.

.01 Natural Ventilation Systems

WORSHIP AREA

The space will be monitored by 4No combined temperature and humidity sensors. These shall be installed in as representative of the space locations as possible as agreed with the Services Consultant and Architect.

The lowest reading CO_2 value and the average of the temperatures shall be used to control the actuators in the 4No TEK Active Vent roof turrets so as to aim to maintain set points of 750ppm CO_2 and a temperature of 22°C.

The CO_2 control shall lead so that in the event of over cooling occurring, such as in winter, the CO_2 target shall be achieved with heating being compensated for by the underfloor heating.

Actuators (supplied by TEK Ltd) to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

A space condition indicator will be provided. This will have two sets of indicator lamps of green, orange and red. One set will be labelled “CO2” and the other “Temperature”. The initial set points will be 750ppm/1500 ppm/2500ppm and 24/26/28°C.

These set points will be used to illuminate the green, orange and red lamps respectively.

The red lamps will have “Open Windows” or similar, to be agreed with the Services Consultant, engraved adjacent to them. The exact set points and any dead bands are also to be agreed with the Services Consultant.

The condition indicator shall nominally be installed to a position adjacent to the ramp. Again, the final location for this shall be agreed with the Services Consultant and Architect.

The system will also respond to the dictated of the external wind/rain sensor as described below.

In addition, manually openable windows are provided which can be used to supplement the above should the occupants wish.

2nd FLOOR NURSERY

The space will be monitored by 2No combined temperature and humidity sensors. These shall be installed in as representative of the space locations as possible as agreed with the Services Consultant and Architect.

The lowest reading CO2 value and the average of the temperatures shall be used to control the actuators in the 2No TEK Active Vent roof turrets so as to aim to maintain set points of 750ppm CO2 and a temperature of 22°C.

The CO2 control shall lead so that in the event of over cooling occurring, such as in winter, the CO2 target shall be achieved with heating being compensated for by the underfloor heating.

Actuators (supplied by TEK Ltd) to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

A space condition indicator will be provided. This will have two sets of indicator lamps of green, orange and red. One set will be labelled “CO2” and the other “Temperature”. The initial set points will be 750ppm/1500 ppm/2500ppm and 24/26/28°C.

These set points will be used to illuminate the green, orange and red lamps respectively.

The red lamps will have “Open Windows” or similar, to be agreed with the Services Consultant, engraved adjacent to them. The exact set points and any dead bands are also to be agreed with the Services Consultant.

The condition indicator shall nominally be installed to a position to be agreed with the Services Consultant and Architect.

The system will also respond to the dictated of the external wind/rain sensor as described below.

In addition, manually openable windows are provided which can be used to supplement the above should the occupants wish.

2nd FLOOR NURSERY/MEETING ROOM

The space will be monitored by 2No combined temperature and humidity sensors. These shall be installed in as representative of the space locations as possible as agreed with the Services Consultant and Architect.

The lowest reading CO2 value and the average of the temperatures shall be used to control the actuators in the 2No TEK Active Vent roof turrets so as to aim to maintain set points of 750ppm CO2 and a temperature of 22°C.

The CO2 control shall lead so that in the event of over cooling occurring, such as in winter, the CO2 target shall be achieved with heating being compensated for by the underfloor heating.

Actuators (supplied by TEK Ltd) to be 24v 0-10v signal modulating with spring return (close) in the event of power failure.

A space condition indicator will be provided. This will have two sets of indicator lamps of green, orange and red. One set will be labelled “CO2” and the other “Temperature”.

The initial set points will be 750ppm/1500 ppm/2500ppm and 24/26/28°C. These set points will be used to illuminate the green, orange and red lamps respectively.

The red lamps will have "Open Windows" or similar, to be agreed with the Services Consultant, engraved adjacent to them. The exact set points and any dead bands are also to be agreed with the Services Consultant.

The condition indicator shall nominally be installed to a position to be agreed with the Services Consultant and Architect.

The system will also respond to the dictated of the external wind/rain sensor as described below.

In addition, manually openable windows are provided which can be used to supplement the above should the occupants wish.

Weather Station

A weather station will be provided which will consist of 2No rain detection sensors, an anemometer and weathervane. This will monitor the prevailing conditions and will close the windward sides of the turrets under the following conditions:

- Wind speed in excess of limit set by turret supplier.
- Wind speed in excess of limit set by turret supplier and rain detected.

A delay will be applied to the above to prevent nuisance alarms.

Should the rain detectors be reporting different results, i.e. indicating that one has failed then an alarm shall be raised on the BEMS and the BEMS will assume that rain exists and therefore should the wind speed exceed the pre-set limits the windward louvres will be closed.

The weather station shall be installed at roof level in a location that is fully exposed to the prevailing weather and is easily accessible for service activities.

Mechanical Ventilation Systems

AHU 01 - CHURCH HALL SYSTEM

This AHU serves to provide tempered air to the 1st Floor Church Hall Area. The AHU is of the double deck type.

The AHU is composed of the following:

- Inlet air damper.
- LTHW pre-heater coil.
- Supply air panel filter.
- Supply air bag filter.
- Rotary heat wheel.
- DX Heat Pump cooling coil.
- LTHW re-heater coil.
- Inverter driven supply fan – powered from the panel.
- Return air panel filter.
- Inverter driven extract fan – powered from the panel.
- Discharge air damper.

When required to run, as described above, the following sequence shall occur:

- Inlet air and discharge isolation dampers shall be commanded to open.
- Once both dampers are open as proven by the operation of their respective end-switches the supply fan will be commanded to start. Should either of the dampers

not be seen to be open within 2 minutes of being commanded to do so an alarm shall be raised on the BEMS.

- When commanded to do so, as described above, the supply fan shall be enabled via its associated inverter. The fan shall run at the speed dictated at commissioning. If the fan is not running within 30 seconds of being commanded to do so or if a fault occurs on the inverter then the enable shall be removed, the dampers commanded to close and an alarm raised on the BEMS.
- When commanded to do so, as described above, the extract fan shall be enabled via its associated inverter. The fan shall run at the speed dictated at commissioning. If the fan is not running within 30 seconds of being commanded to do so or if a fault occurs on the inverter then the enable shall be removed, the dampers commanded to close and an alarm raised on the BEMS.
- Once the supply fan is running the pre-heater valve will be controlled to ensure that air at a minimum of 12°C is delivered from the coil as measure by a duct mounted temperature sensor. Should, when operating, this temperature not be achieved then an alarm shall be raised on the BEMS. The coil shall be protected by a manual reset serpentine frost thermostat laced across the downstream face of the coil. This shall be set just below the air setpoint and if activated will, via hardwired interlocks cause the system to shut down and will raise an alarm on the BEMS. In this event the AHU valves shall be driven to the open position.
- A 3-port control valve shall be employed for control of the coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.
- The condition of the panel and bag filters shall be monitored by air differential pressure switches. These shall be set such that they will be activated should the respective filter become clogged. In this event an alarm shall be raised on the BEMS.
- The heat wheel and heating coil shall be controlled in sequence with the aim of achieving a supply air temperature of 12°C.
- Should the supply air require heating and the extract air have sufficient heat in it to provide useful heat to the supply airstream then the wheel will be enabled. The speed of rotation shall be modulated to attempt to achieve setpoint.
- The heat wheel shall be monitored by the BEMS for fault and run conditions. Should the wheel report a fault or is not seen to run when enabled then an alarm shall be raised on the BEMS.
- Should the thermal wheel either not be providing enough heat to achieve setpoint or not be in operation for any reason then the DX coil shall come into operation and shall modulate in order to achieve the supply air setpoint of 12°C.
- A DX Heat Pump is employed for control of the cooling coil. A thermostat will send a signal to the DX system control panel to automatically achieve a supply air setpoint of 12°C.
- A 3-port control valve shall be employed for control of the LTHW re-heat coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.
- The condition of the extract panel filter shall be monitored by an air differential pressure switch. This shall be set such that it will be activated should the filter become clogged. In this event an alarm shall be raised on the BEMS.
- The AHU will operate continuously at a trickle speed as set at commissioning. A minimum of 4 ceiling mounted PIR motion detectors are to be provided. The PIRs will be selected to ensure that the whole of space is in range of the device. Should any of the PIRs detect movement then the AHU will be enabled to run under control of space mounted CO_2 detectors as described below. Once activated the AHU will run for a minimum time of 30 minutes.

- The space will be provided with 4 CO_2 sensors. When enabled the AHU will modulate the speed of the fans to maintain a maximum CO_2 content of 1500ppm in the space.

AHU 02 - GENERAL BUILDING SYSTEM
This AHU serves to provide tempered air to the general areas of the building. The AHU is of the double deck type.

The AHU is composed of the following:
- Inlet air damper.
- LTHW pre-heater coil.
- Supply air panel filter.
- Supply air bag filter.
- Rotary heat wheel – powered from the panel.
- LTHW heating coil.
- Inverter driven supply fan – powered from the panel.
- Return air panel filter.
- Inverter driven extract fan – powered from the panel.
- Discharge air damper.

When required to run, as described above, the following sequence shall occur:

- Inlet air and discharge isolation dampers shall be commanded to open.
- Once both dampers are open as proven by the operation of their respective end-switches the supply fan will be commanded to start. Should either of the dampers not be seen to be open within 2 minutes of being commanded to do so an alarm shall be raised on the BEMS.
- When commanded to do so, as described above, the supply fan shall be enabled via its associated inverter. The fan shall run at the speed dictated at commissioning. If the fan is not running within 30 seconds of being commanded to do so or if a fault occurs on the inverter then the enable shall be removed, the dampers commanded to close and an alarm raised on the BEMS.
- When commanded to do so, as described above, the extract fan shall be enabled via its associated inverter. The fan shall run at the speed dictated at commissioning. If the fan is not running within 30 seconds of being commanded to do so or if a fault occurs on the inverter then the enable shall be removed, the dampers commanded to close and an alarm raised on the BEMS.
- Once the supply fan is running the pre-heater valve will be controlled to ensure that air at a minimum of 5°C is delivered from the coil as measure by a duct mounted temperature sensor. Should, when operating, this temperature not be achieved then an alarm shall be raised on the BEMS. The coil shall be protected by a manual reset serpentine frost thermostat laced across the downstream face of the coil. This shall be set just below the air setpoint and if activated will, via hardwired interlocks cause the system to shut down and will raise an alarm on the BEMS. In this event the AHU valves shall be driven to the open position.
- A 3-port control valve shall be employed for control of the coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.
- The condition of the panel and bag filters shall be monitored by air differential pressure switches. These shall be set such that they will be activated should the respective filter become clogged. In this event an alarm shall be raised on the BEMS.
- The heat wheel and heating coil shall be controlled in sequence with the aim of achieving a supply air temperature of 16°C.

- Should the supply air require heating and the extract air have sufficient heat in it to provide useful heat to the supply airstream then the wheel will be enabled. The speed of rotation shall be modulated to attempt to achieve setpoint.
- The heat wheel shall be monitored by the BEMS for fault and run conditions. Should the wheel report a fault or is not seen to run when enabled then an alarm shall be raised on the BEMS.
- Should the thermal wheel either not be providing enough heat to achieve setpoint or not be in operation for any reason then the heating coil shall come into operation and shall modulate in order to achieve the supply air setpoint of 16°C.
- A 3-port control valve shall be employed for control of the coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.
- The condition of the extract panel filter shall be monitored by an air differential pressure switch. This shall be set such that it will be activated should the filter become clogged. In this event an alarm shall be raised on the BEMS.
- The AHU will operate continuously at a trickle speed as set at commissioning. Each space will be provided with a ceiling mounted PIR motion detector. The PIRs will be selected to ensure that the whole of space is in range of the device. Should any of the PIRs detect movement then the AHU will be enabled to run under control of space mounted CO_2 detectors as described below. Once activated the AHU will run for a minimum time of 30 minutes.
- Each space will be provided with a CO_2 sensor. When enabled the AHU will modulate the speed of the fans to maintain a maximum CO_2 content of 1500ppm in any one space.

AHU 03 - KITCHEN SUPPLY

This AHU is composed of the following:

- Inlet air damper.
- LTHW pre-heater coil.
- Panel filter.
- Bag filter.
- LTHW heating coil.
- Inverter driven supply fan – powered from the panel.
- Supply isolation damper.

When required to run, as described above, the following sequence shall occur:

- Inlet air and supply isolation dampers shall be commanded to open.
- Once both dampers are open as proven by the operation of their respective end-switches the supply fan will be commanded to start. Should either of the dampers not be seen to be open within 2 minutes of being commanded to do so an alarm shall be raised on the BEMS.
- When commanded to do so, as described above, the supply fan shall be enabled via its associated inverter. The fan shall run at the speed dictated by the chef's speed control. If the fan is not running within 30 seconds of being commanded to do so or if a fault occurs on the inverter then the enable shall be removed, the dampers commanded to close and an alarm raised on the BEMS.
- Once the supply fan is running the pre-heater valve will be controlled to ensure that air at a minimum of 5°C is delivered from the coil as measure by a duct mounted temperature sensor. Should, when operating, this temperature not be achieved then an alarm shall be raised on the BEMS. The coil shall be protected by a manual reset serpentine frost thermostat laced across the downstream face of the coil. This shall be set just below the air setpoint and if activated will, via hardwired interlocks

cause the system to shut down and will raise an alarm on the BEMS. In this event the AHU valves shall be driven to the open position.

- A 3-port control valve shall be employed for control of the coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.
- The condition of the panel and bag filters shall be monitored by air differential pressure switches. These shall be set such that they will be activated should the respective filter become clogged. In this event an alarm shall be raised on the BEMS.
- When the AHU is operating it will maintain a supply air setpoint of 19°C, this shall be varied by +/- 5°C in order to maintain a target space temperature of 20°C as measured by a space temperature sensor, a setpoint adjuster on the chef's panel shall allow manual variation by +/-3°C.
- A 3-port control valve shall be employed for control of the coil. The volume passing through the valve in operation shall be measured by the BEMS and summed with all others on its respective pumped circuit in order to set the volume of water delivered by the associated pump set in order to accurately match the requirements of the circuit.

KEF 01 - KITCHEN EXTRACT FAN

An extract fan is to be provided to serve the kitchen, which shall be powered and controlled from the MCC. This will be equipped with an EC motor and discharge damper. The fan will not be allowed to operate until the damper has been seen to be open via a damper actuator microswitch.

The fan shall be powered from the panel with its speed controlled under the dictates of the local controller, as described below. It shall be monitored for a running condition via a panel-mounted CT switch. In the event of a run condition not being seen after 15 seconds of being called for, an alarm shall be raised on the BEMS.

The panel shall be provided with switches to allow the fan to be overridden on or off if desired, and panel lamps shall be provided to indicate that the fan is requested to run or has a fault.

<u>Kitchen Local Controller</u>

A local control panel shall be provided to the kitchen in a location to be agreed with the Services Consultant and Architect. This will be equipped with a user switch to allow the ventilation system to be overridden off, or variable ventilation rates to be selected. Lamps on the panel shall be provided to indicate whether the AHU or extract fan is running if requested to do so, or has failed. Variable speed control between 30 – 100% of fan duty, the supply fan will be set to track this at 85%.

The ventilation rates will be set during air balancing and agreed with the Services Consultant.

A set point adjustment knob shall be provided to the panel fascia to allow the supply air set point to be varied by ± 3°C from the base set point, as described above.

<u>Kitchen Gas Safety System</u>

A kitchen gas safety system, as manufactured by Medem Ltd (or approved equal), shall be provided.

This will only allow the kitchen gas valve to be open if the supply and extract systems are operating, no fire or other safety alarm is in existence, and if the integrity of the gas pipework is seen to be intact.

The kitchen safety system shall have an emergency shutoff button on it which, if activated, shall close the gas valve.

The system will be monitored by the BEMS for emergency and fault conditions. In the event of these being seen, an alarm will be raised on the BEMS.

.02 LTHW Heating

Boilers
The building is provided with 3No LTHW boilers, which will be powered from the panel.

When required to run the boilers will be enabled such that a common flow temperature set point of 80°C is maintained.

The boilers will be monitored for a fault and in the event of a fault being detected the associated boiler shall be shut down and an alarm raised on the BEMS head end PC system.

The panel shall be provided with switches to allow the individual boilers to be overridden on or off if desired and panel lamps shall be provided to indicate that the boilers are requested to run or have a fault.

The system shall ensure even usage of the boilers by automatically rotating their duty such that the lead boiler changes on a weekly basis.

The boilers will not be enabled to run until the primary pumps have been seen to run for 15 seconds.

Each boiler has its own in-built shunt pump which will be controlled by the boiler and have suitable overrun provision built-in. However, the need to run secondary pumps in order to assist with heat dissipation shall be considered.

The boiler system shall be enabled should either P1, P2 or P3 pump sets be initiated.

Pump Sets
LTHW will be distributed to the various systems by means of a number of pump sets:

P1: LTHW AHU Secondary Pump Set
P2: Underfloor heating Secondary Pump Set
P3: LTHW DHWS Primary Pump Set
P4: DHWS Return Pump

P1: LTHW (CT) AHU Secondary Pump Set
A run and standby set of pumps will be provided to serve the constant temperature circuit. These shall be enabled should either AHU valve be seen to be open more than 5%.

They are equipped with integral inverters and shall be permanently powered from the panel.

They shall be arranged as duty/standby such that one pump will be enabled when required to run. The lead pump will be changed on a weekly basis.

The flow status of the pumps will be monitored and in the event of a failure occurring the enabled pump will be disabled and the current standby pump enabled.

In this event the failed pump will be locked out of the control sequence and an alarm raised on the BEMS.

The panel shall be provided with switches to allow the pumps to be overridden on or off if desired and panel lamps shall be provided to indicate that a pump is requested to run or has a fault.

The water flow temperature from the pumps shall be measured using an immersion temperature sensor.

This value shall be used for monitoring and out of limits alarm generation.

P2: LTHW (VT) Underfloor heating system Secondary Pump Set

A run and standby set of pumps will be provided to serve the variable temperature circuit. These shall be enabled in the event of a heat demand being seen to exist at the underfloor heating manifold.

They are equipped with integral inverters and shall be permanently powered from the panel.

They shall be arranged as duty/standby such that one pump will be enabled when required to run.

The lead pump will be changed on a weekly basis.

The flow status of the pumps will be monitored and in the event of a failure occurring the enabled pump will be disabled and the current standby pump enabled.

In this event the failed pump will be locked out of the control sequence and an alarm raised on the BEMS.

The panel shall be provided with switches to allow the pumps to be overridden on or off if desired and panel lamps shall be provided to indicate that a pump is requested to run or has a fault.

The water flow temperature from the pumps shall be measured using an immersion temperature sensor. This value shall be used for monitoring and out of limits alarm generation as well as a control value for the variable temperature circuit.

A three port valve and actuator shall be provided to achieve the variable flow temperature as required by the underfloor heating circuits. This valve shall be controlled such that at -4°C outside air temperature a flow temperature of 55°C shall result and at 20°C a flow temperature of 20°C shall result. Should either the flow temperature setpoint be seen to be at 20°C for in excess of one hour or the outside air temperature be in excess of 16°C for one hour the system shall be shut down.

In addition to the above, in order to ensure that in the case of a fault condition dangerously hot water is not delivered, a manual reset immersion thermostat shall be provided in the flow from the pumps. This shall nominally be set to 65°C such that if operated the pumps shall stop and the valve shall go to bypass. An alarm shall be raised on the BEMS head end and the plant shall not resume operation until both the thermostat has been reset and a software reset button has been activated.

A 3-port diverting valve as shown in Detail 'A' on the drawings is to be installed at each underfloor heating manifold and this is to be controlled in tandem with the manifold pump/valve so that when a manifold shuts down the diverting valve will open.

P3: LTHW DHWS Primary Pump Set

A run and standby set of pumps will be provided to serve the constant temperature circuit. These shall be initiated should the water temperature in the calorifier drop below 56°C within the occupancy time of the building.

They are equipped with integral inverters and shall be permanently powered from the panel.

They shall be arranged as duty/standby such that one pump will be enabled when required to run. The lead pump will be changed on a weekly basis.

The flow status of the pumps will be monitored and in the event of a failure occurring the enabled pump will be disabled and the current standby pump enabled.

In this event the failed pump will be locked out of the control sequence and an alarm raised on the BEMS.

The panel shall be provided with switches to allow the pumps to be overridden on or off if desired and panel lamps shall be provided to indicate that a pump is requested to run or has a fault.

The water flow temperature from the pumps shall be measured using an immersion temperature sensor.

This value shall be used for monitoring and out of limits alarm generation.

P4: DHWS Return Pump
A pump shall be provided on the system return which shall be powered and controlled from the panel. This shall run 24/7 and the return water temperature monitored. Should this be seen to fall below 55°C for in excess of 10 minutes an alarm shall be raised on the BEMS head end and if not already the hot water generator shall be enabled.

LTHW Heating Pressurisation Unit
The heating pressurisation unit is to be permanently powered from the panel, and the unit is to be monitored for a fault.

In the event of a fault the system is, via hardwired interlocks, to shut down all plant associated with the heating system and raise an alarm on the BEMS head end.

Boiler Gas Safety System
A gas safety system shall be provided consisting of a solenoid gas valve, electro-thermal links above the boilers. An emergency stop button shall be provided adjacent to the plantroom entrance.

The panel will also be linked to a local fire alarm relay provided by the fire alarm Mechanical Contractor.

In the event of either the fire alarm activating, an electro-thermal link being tripped or the emergency stop button being activated all plant shall, via hardwired interlocks, immediately shut down and the gas valve shall close. An alert will be raised on the BEMS head end system.

.03 **Underfloor Heating Manifold**
The manifolds will be supplied with LTHW from Pump Set P2, which will be controlled via a demand signal from the underfloor wiring centres and the zone time schedule.

Underfloor heating is to be installed in all areas as shown on the drawings and will be served by a number of manifolds, which will operate under the dictate of their own controls.

The number of zones is indicated on the drawings, and each zone will be individually controlled via a room thermostat, which will be taken via the wiring centres, from which a signal will be taken back to the new BEMS to the request heat.

A low temperature (frost) sensor will be provided. This will be located in the most vulnerable part of the building as agreed with the Services Consultant and Architect.

The underfloor heating manufacturer will provide the wiring centres and room thermostats and these and all associated wiring will be installed by the BEMS Contractor.

Commissioning of the system will be by the UFH Contractor in conjunction with the BEMS Contractor.

.04 **DHWS Calorifiers**

The Secondary Pump P3 circulates LTHW to the calorifiers.

The calorifiers will be installed in the Roof plantroom to provide hot water to the various basins and sinks.

Temperature sensors in each calorifier shall monitor the water temperature and will control the associated LTHW 3-Port valve to maintain a water temperature of 60°C within the respective calorifier.

There is a DHWS return pump which is to be controlled via the BEMS as described above.

A high limit thermostat set to 65°C shall, if activated, will cause the LTHW valve to close via hardwired interlocks. In this event, an alarm will be raised on the BEMS.

In addition, a 6kW immersion heater will be provided as back up in each calorifier. This will be locally powered from a supply provided by the Electrical Contractor and, as such, will allow the heater to be switched on independently of the control system.

Water Conditioner

A magnetic physical water conditioner on the incoming water supply will be installed at the point of entry to the building adjacent to the cold water booster set. Power for this will be provided by the Electrical Contractor.

The unit shall be a 'Hydromag' unit, as manufactured by Hydrotec (UK) Ltd, size 54mm, installed as per the manufacturer's instructions.

The unit shall be supplied complete with a control panel fixed to the wall adjacent to the unit, (also supplied by Hydrotec [UK] Ltd) and shall be powered via a local supply provided by the Electrical contractor (final wiring by the BEMS Contractor), with volt free connection to be wired back to the BEMS, also for fault alarm notification.

Main Entrance Door Heater

A vertical door heater shall be provided to the main entrance which shall be locally powered by the Electrical Contractor. It will be equipped with its own controls and, as such, will be merely enabled by the BEMS on a timed basis and, if a suitable connection is available, monitored for a fault condition.

.05 **Energy Monitoring**

No energy monitoring by the BEMS shall be provided at this time, but facility shall be made for its addition at a later date.

Heat meters are to be provided by the BEMS Contractor these shall be suitable for the application and shall be as manufactured by Kamstrup, type MULTICAL402 or approved equal. The following meters are required:

AHU 01, 02 and 03.
Each LTHW distribution pump set (3no).

Water Meters
Water meters shall be provided to the following:

- Incoming mains – monitored via the WAT03 device.
- Kitchen

The BEMS shall monitor these via a data connection (e.g. mbus) not via a pulse (volt free contact) connection. These shall be installed by the Mechanical Contractor.

See drawings for locations.

Gas
The BEMS shall monitor the main gas consumption via a meter provided by the Mechanical Contractor to the following:

- Boilers
- 1st Floor Kitchen

Electricity
The main LV board and distribution boards will be provided with Modbus compatible meters (provided with the associated boards by the Electrical Contractor). The BEMS Contractor will connect these to a network to allow the consumption to be monitored.

All meter consumption shall be recorded by and made available for display on the BEMS supervisory system. In addition, should it shall be possible to export this data to a 3rd party system.

.06 **Design**
Prior to any designs being implemented, e.g. panels or software being created, a full set of design documents such as descriptions of operations and schematics or panel wiring diagrams are to be submitted to the Services Consultant for approval.

The descriptions of operation are to fully detail how the control software will include frost and fabric protection routines for the benefit of the building and optimisation protocols for energy efficiency. In addition, they are to detail the format of the zoning of the various systems for time control. System schematics are to accompany the descriptions to aid both the Services Consultants and Client's understanding of the system. They are to be written in plain English.

.07 **Demonstration**
On completion of the works the BEMS/Mechanical Contractor will demonstrate the system to the Services Consultant and it will not be considered to be complete until they are completely satisfied and has confirmed their satisfaction in writing.

.08 **Mechanical Services Wiring**
The Controls/BEMS Contractor shall allow for the complete electrical installation to the mechanical services installation.

This shall include the supply and installation of all necessary containment, inter-connecting wiring, local isolating switches, plug and sockets etc., together with the following items:

a) Installation of power wiring serving the mechanical equipment detailed herein.
b) The installation of all control wiring to items of equipment and sensors within building.
c) Earthing and provision of all equipotential earth bonding to all pipe and metalwork.

NOTE: CONTAINMENT TO BE PROVIDED BY THE ELECTRICAL CONTRACTOR FOR ALL CONTROLS CABLING REQUIRED FOR THE SUCCESSFUL INSTALLATION AND COMMISSIONING OF THE BEMS/ CONTROLS SYSTEM – THE MECHANICAL CONTRACTOR IS TO LIAISE WITH THE MAIN CONTRACTOR AND THE ELECTRICAL CONTRACTOR TO ENSURE ALL REQUIREMENTS ARE MET.

Wiring shall be carried out in PVC insulated single or multicore cables (as required) run in HG PVC conduit. Provision shall be made by the BEMS Contractor for adequate RCD protection for concealed low-voltage cables, or otherwise the provision of extra-low-voltage cables.

The BEMS Contractor shall take note that all wiring 'drops' to detectors etc. shall be flush in the building fabric and enclosed in HG PVC conduit, forming a vertical and re-wireable wiring route between the outlet and the ceiling void. All such conduits shall be installed by the Electrical Contractor.

Separate green/yellow circuit protective conductors shall be installed for each circuit and shall, unless otherwise stated, be of the same cross sectional area as the phase conductors.

Final connections to circulating pumps etc. shall be made with multi core HOFR flexible cables to BS6500 via multi pin plug and socket (number of poles to suit).

Where cables pass through a wall or ceiling, the Main Contractor shall ensure that the integrity of that wall/ceiling is maintained against the passage of fire and shall supply and install all protective measures necessary.

On completion of all work, and before the plant is put into operation, the BEMS Contractor shall ensure that all overloads, thermostats etc., are set up and functioning correctly and that all motors and pumps etc. are rotating in the desired direction to give the desired control function.

On completion, the whole of the Electrical Installation specified herein shall be tested by the Electrical Contractor, in accordance with BS 7671: 2008 (2011).

The BEMS Contractor shall obtain Completion and Test Certificates and forms from the NICEIC. These forms shall be completed and signed by the BEMS Contractor for inclusion within the Operating and Maintenance Manual.

.09 **Maintenance**

The BEMS Contractor shall allow for the provision of 2 years maintenance cover within their return.

5. MECHANICAL SERVICES TENDER SUMMARY - PRICING SCHEDULE

Ref	Item	Price (£)
1	New incoming Gas.	
2	Internal Gas Distribution system.	
3	Provision and installation of new LTHW gas fired boilers in roof plantroom together with Pressurisation Unit/expansion vessel/dosing pot and quick fill facility.	
4	LTHW distribution systems to serve the AHUs, Underfloor Heating and DHWS calorifiers.	
5	Underfloor Heating System including wiring centre, manifolds, manifold cabinets, individual pumps, controls, the screed and associated floor insulation.	
6	Active Roof Turret Ventilation System to serve the Worship Area.	
7	Active Roof Turret Ventilation System to serve 2nd Floor Nursery.	
8	Active Roof Turret Ventilation System to serve 2nd Floor Nursery/Meeting Room.	
9	AHU 01 Ventilation System to serve the Church Hall (including ASHP).	
10	AHU 02 Ventilation System to serve the General Areas.	
11	AHU 03 Ventilation System to serve the Kitchen.	
12	Ventilation Systems to the Baby Change/Kitchenette/WCs, etc.	
13	Noise Control (attenuators etc).	
14	Vibration Control (AV mounts, flexible connections etc).	
15	New incoming Mains cold water.	
16	Domestic Cold Water system.	
17	Domestic Hot Water system including DHWS Calorifiers and associated controls/return pump and all necessary expansion vessel, drain cocks, PRV, Safety valves, controls and TMVs, etc,	
18	Thermal Insulation.	
19	Above Ground Soil and Waste Systems, including condensate/pressure relief valve drains.	
20	New Controls and BEMS and associated wiring.	
21	Electrical works in association.	
22	Flushing/Cleaning and Water Treatment to Mains Cold Water, LTHW, Hot and Cold Water Systems.	
23	Inspection, Testing and Certification.	
24	Provision of Record Documentation.	
25	2 Year Maintenance.	
26	Other works within the specification or drawings not covered above.	
25	**Sub-total**	
26	Contingency	£ 10,000.00
25	**Total**	