



SPECIFICATION

FOR THE

MECHANICAL SERVICES INSTALLATION

AT

COOMBE HOSPITAL WATER TANK UPGRADE AUGUST 2026

LINKED PRACTICES

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MECHANICAL SERVICES SPECIFICATION

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MECHANICAL SERVICES SPECIFICATION

PREFACE

1. DEFINITIONS:

- 1.1. The definitions ascribed to the parties and consultants to the contract in the Form of Tender shall prevail throughout this Specification.
- 1.2. 'Indicated' as used in 'as indicated', 'where indicated', 'unless otherwise indicated' and like phrases shall mean indicated in the addenda to the Specification and/or in the equipment schedules, or on the drawings or any other relevant contract documentation. 'Specified' shall be interpreted similarly.
- 1.3. 'Approval' means approval in principle from the Engineer, and does not infer that the Contractor is in any way relieved of the consequential responsibility of adhering to the spirit of the contract documentation with regard to standard of workmanship, materials and design intent.

2. INTERPRETATION:

- 2.1. Section 1: Indicates the scope of the Contractor's responsibility to provide a complete and satisfactory working installation, complying with all necessary requirements, for hand-over to the Employer.
- 2.2. Section 2: Provides a description of the mechanical services systems, along with applicable design criteria and any other relevant information.
- 2.3. Section 3: The Standard Specification sets out the requirements and standards for workmanship, materials and equipment. The Contractor shall ensure that the installation conforms to the standard of workmanship called for and that materials and equipment are to the standard required.
- 2.4. Appendices: Provides additional details particular to the project, including any amendments and additions to the Standard Specification, and schedules of equipment.
- 2.5. This Specification shall be read in conjunction with the general conditions of contract, drawings and all other contract documentation. Any discrepancy shall be referred to the Engineer in writing for clarification as soon as practicable.

SECTION 1 - GENERAL REQUIREMENTS

1. SCOPE OF MAIN CONTRACTOR'S & SPECIALIST CONTRACTOR'S RESPONSIBILITIES:

- 1.1. The Main Contractor, and where the specialist contractor acts as main contractor, shall be entirely responsible for the works set out in the contract documentation, whether under construction or during tests, until the works have been taken over, or deemed to have been taken over under the conditions of the contract. Obtaining the Engineer's or Employer's Representative approval does not relieve the Main Contractor of this responsibility.
- 1.2. Unless otherwise indicated, the works shall include the supply, delivery, installation, testing, commissioning, setting to work, making good any defects that occur during the defects liability period, provision of 'as-installed' drawings and maintenance and operating manuals, and the whole of the labour and materials necessary to form a complete installation, whether or not all the necessary components are indicated.
- 1.3. The Main Contractor shall be responsible for ensuring that any firm, on Employer's instruction or otherwise, appointed by him as a specialist contractor (in this case Mechanical, Electrical & Transport Specialist Contractors) a supplier or as a supplier to the specialist complies with and fulfils all the relevant undertakings and conditions described in the contract documentation. The Main Contractor shall also be responsible for incorporating the works of his Specialist Contractors into the programme of works.
- 1.4. The Main Contractor shall conduct inspections and tests and compile reports during manufacture or fabrication on or off site, as and when required, to ensure that quality, workmanship, delivery, assembly, erection, testing, setting to work and completion by the Specialist Contractors are satisfactory.
- 1.5. The Main Contractor shall, by submitting a tender, guarantee that all materials, equipment and work carried out shall be 'Fit for the Purpose' and shall secure similar guarantees from his appointed Specialist Contractors and specialist's suppliers.
- 1.6. The design of plant, equipment, specialist installations or materials used by the Main Contractor and or Specialist's Contractors and requiring the input of the manufacturer's specialist designers shall be the responsibility of the manufacturer/supplier of the specific plant, equipment, specialist installations or materials. The Main Contractor and or Specialist's Contractors shall, when placing orders, be responsible for ensuring that all relevant information regarding every aspect of the project is passed on to the manufacturer/supplier and for ensuring that the plant, equipment, specialist installations or materials are suitable for the application and comply with the Engineer's design intent and the Specification.

- 1.7. Unless otherwise indicated, all materials and equipment to be installed shall be new. Equipment shall be installed in accordance with manufacturers' written instructions.
- 1.8. Where equipment is supplied by others as free-issue items, the Main Contractor or Specialist Contractor if so agreed, shall take delivery, erect, test and commission the equipment unless otherwise indicated.
- 1.9. The Main Contractor shall ensure before ordering that all equipment can be installed in allotted spaces and shall maintain adequate access for maintenance and repair.
- 1.10. Notice prior to cover shall be given in reasonable time by the Main Contractor to the Engineer whenever any works or materials are intended to be covered by earth, lagging, structural duct covers, walls, floors, ceilings, building in, or otherwise.
- 1.11. The Main Contractor shall ensure to include for all services expansion and flexible joints as necessary to cross building expansion joints.
- 1.12. The Main Contractor shall regard all maps, plans, drawings, sketches, etc. of the works as highly confidential, all as set out in accordance with the main contract conditions, and shall only release them to other persons on a need-to-know basis.
- 1.13. The whole of the works shall be carried out to the complete satisfaction of the Engineer and Employer's Representative who shall reserve the right to reject any workmanship and materials that, in their opinion of, do not conform to the Specification. The Main Contractor shall be obliged to carry out such alterations or replacements of materials at his own expense.
- 1.14. The Main Contractor shall not interrupt or interfere with any existing services without prior written permission from the Employers representative.
- 1.15. The Main Contractor and Specialist Contractor shall note that the Engineer reserves the right to change, amend or modify the specifications, drawings, design or layout as required throughout the contract and in accordance with the contract conditions

2. STANDARDS AND CODES OF PRACTICE:

- 2.1. Unless specifically stated otherwise, or approved by the Engineer, installation, materials and equipment shall be in accordance with the relevant Irish, European and British Standards and Codes of Practice and CIBSE Guidelines, whether indicated in this Specification or not.
- 2.2. Although relevant Standards and Codes of Practice are referred to in this Specification, the Main Contractor and Specialist Contractor shall ensure that all Standards and Codes of Practice shall be current editions dated three months before the date for return of tenders.

- 2.3. Any differences between these Standards and Codes of Practice and any part of this Specification shall be brought to the attention of the Engineer for clarification.
- 2.4. Commodities conforming to Standards shall be clearly and indelibly marked with the Standard reference. Where this is impracticable, the relevant advice and delivery notes shall include the Standard reference with which they are to comply.
- 2.5. Where commodities/services are specified to be by registered/approved firms under Certification and/or Quality Assurance schemes, the proposed firm must be a current participant in the relevant scheme.
- 2.6. Certificates or compliance with Standards, Certification schemes and/or Quality Assurance schemes shall be provided to the Engineer on request.

3. NATIONAL AND LOCAL AUTHORITIES:

- 3.1. The Main Contractor and Specialist Contractor shall ensure that all materials, items of equipment, methods of installation and standards of workmanship are in compliance with the recommendations and requirements of the relevant national and local authorities and shall arrange for such authorities to witness any testing which may be desired.

4. ACTS AND REGULATIONS:

- 4.1. The installation(s) shall comply with all Acts, relevant Statutory Instruments and Regulations including any special Regulations issued by the electricity, gas and/or water authorities. The tender shall be based on the Acts and Regulations current on the date for return of tenders. If these Acts and/or Regulations are amended or new Acts and/or Regulations are enacted after that date the Contractor shall inform the Engineer and Employer's Representative immediately.

5. HEALTH AND SAFETY:

- 5.1. The Main Contractor and Specialist Contractor (s) shall comply fully with the health and safety requirements as detailed in the Main Contract and all relevant Safety, Health and Welfare at Work Statutory Instruments.

- 5.2. All equipment deployed in a temporary capacity (during installation works) and permanently as part of the project contract works shall comply with the current European directives in connection with safety of machinery and electrical equipment:-

- 5.2.1. Machinery Directive (2006/42/EC)
- 5.2.2. The low Voltage Directive (2014/35/EU)
- 5.2.3. Electro Magnetic Compatibility (2014/30/EU)

All such equipment shall carry the "CE" marking. Equipment not bearing this marking will be rejected by the Engineer and the Main / Specialist Contractor shall be required to replace it with certified (and marked) equivalents without cost penalty to the Employer.

- 5.3. The hardware/software/firmware supplied shall be accompanied by documentation stating this conformity.

6. INTERIM CLAIMS:

- 6.1. Claims for interim payment shall be in accordance with the information set out in the Main Contract, Schedule Part 1, Section L, Payments Particulars.
- 6.2. The specialist progress claims shall be broken down as per the form of tender.
- 6.3. Interim claims in respect of specialists' works shall be accompanied by a certificate confirming that the works executed and materials on site under the claim are in accordance with the contract documentation. Failure to provide this certificate will invalidate the claim.

7. ASBESTOS MATERIALS:

- 7.1. Asbestos materials shall not be installed. This requirement applies to major items, e.g. thermal insulation, and to sundry minor components such as gaskets, fire seals and valve packing.

8. CFCS AND HCFCs:

- 8.1. Products containing and/or requiring the use of CFCs in their manufacture will not be permitted. Those containing and/or requiring the use of HCFCs may only be used with the permission of the Engineer. The Main Contractor shall confirm in writing that such products are free of CFCs and/or HCFCs prior to delivery to site.

9. SITE ADMINISTRATION:

- 9.1. The Main Contractor and Specialist Contractor(s) shall provide all necessary supervision during the execution of the works. Suitably qualified engineering staff shall be employed and given charge of the site works from commencement to completion. Supervisory staff shall be on site during the whole of the time that the work is in progress and shall be authorised to receive instructions from the Engineer on the Contractor's behalf.
- 9.2. The Main Contractor and Specialist shall allow for attendance at all site meetings involving the services installations, and for attendance at site visits by the Engineer, for the duration of the contract.
- 9.3. The Main Contractor shall provide staff of sufficient number and competence as necessary in the opinion of the Engineer and Employer's Representative for preparing programmes, records, working drawings, builder's work drawings, progress drawings and any other documentation as is required for efficient and satisfactory execution of the works.
- 9.4. The Specialist Contractor shall provide all necessary staff as and when required to liaise with the Main Contractor in the production and maintenance of the overall works programme. Such staff shall also engage in programming and the monitoring of progress within the overall programme. The programme and required updates are to be in compliance with Clause 4.9 of the Main Contract Conditions, and shall be available to the Engineer on request.
- 9.5. The Main Contractor shall submit a type written report detailing the manpower and plant on site in relation to the services installations in accordance with the terms of the main contract.

10. SPECIALIST SERVICES DRAWINGS AND CO-ORDINATION:

- 10.1. The definition of drawing types applying to the works shall be as set out in BSRIA Technical Note TN21/97 Appendix 4 which is attached as an appendix to this specification.
- 10.2. The tender drawings associated with this contract have been brought to the stage of *detailed design drawings* as detailed in TN21/97. These drawings show the locations of plant items and services routes in such detail as to indicate the design intent and the initial co-ordination of services (design stage) with the building structure. The drawings do not indicate the precise position of services, but it should be feasible to install the services within the general routes and general locations indicated, and to produce *co-ordinated drawings* or *installation drawings* without major re-routing of services. Symbol and line conventions are in accordance with the schedule of symbols and notations issued with the tender documents.

- 10.3. The Main Contractor shall have responsibility for performing the overall co-ordination process in respect to all building services with each other and with the building elements. The Main Contractor shall assign to this task staff with proven knowledge and experience of building services to ensure that the service co-ordination activities are successfully completed. The responsibilities of the staff so assigned shall include but are not limited to: -
- 10.3.1. The realistic programming of all building services works and activities and the incorporating of this programme into the main contract programme.
 - 10.3.2. The timely and adequate production, by the services specialist contractors, of drawings as described below.
 - 10.3.3. The timely and adequate provision of services related samples, patterns, mock-ups and setting out details for design team comments.
 - 10.3.4. The interpretation of all building services drawings and specifications and the resolution of queries raised by the building services and other specialist contractors and, if necessary, obtaining clarification or instructions from the design team.
 - 10.3.5. The day to day co-ordination of site setting out of building services and sequencing of installation to ensure that systems are not damaged due to premature installation.
 - 10.3.6. Being present at all meetings called to discuss building services and to report on the works and progress.
 - 10.3.7. The timely and realistic programming of inspections, testing, commissioning and handover of the building services works, all in accordance with the services specification, and in sufficient detail to provide for a design team option to attend during these activities.
 - 10.3.8. The timely and realistic programming of the provision of record drawings and maintenance manuals, in accordance with the services specifications.
 - 10.3.9. Any further activities considered necessary by the Main Contractor in order to fulfil his obligations with regard to services co-ordination.
- 10.4. The specialist contractor associated with the mechanical installation shall undertake the role of Lead Services Co-ordinator. This specialist contractor shall take the lead, under the direction of the Main Contractor, in the services co-ordination activities. These activities and responsibilities include but are not limited to the following:-
- 10.4.1. Before any installation work commences and in time to meet programme dates, the Lead Services Co-ordinator shall meet with representatives of all relevant parties associated with the works to examine all drawings and all aspects of the detailed services co-ordination. Co-ordination meetings shall be of sufficient number to ensure that the co-ordination of services with each other and the building structure, together with the sequencing of installation, is successfully carried out.

- 10.4.2. From information agreed at the co-ordination meetings, the Lead Services Co-ordinator shall develop and produce co-ordination drawings. The co-ordination drawings shall be of sufficient detail to demonstrate that all services can be installed with adequate space for access, commissioning, and ongoing maintenance. Access points for commissioning and maintenance shall be, as far as is practicable, grouped to minimise the number of points required and located in areas where they will cause the least disruption to the functioning of the building when in use.
- 10.4.3. When the Lead Services Co-ordinator completes the co-ordination drawings and agrees the proposals with all relevant parties, the co-ordination drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Lead Services Co-ordinator shall revise the proposals until agreement is reached with all parties.
- 10.5. The specialist contractors shall co-operate fully with the Main Contractor to ensure that the services co-ordination activity is successfully completed.
- 10.6. Based on the final agreed co-ordination drawings, the Specialist Contractor shall develop and produce installation drawings for the works included in his contract. The installation drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Specialist Contractor shall revise these drawings until agreed by all parties.
- 10.7. When the installation drawings are agreed and completed, the Specialist Contractor shall develop and produce *builder's work drawings (installation stage definition)* for the services included in his contract. The builder's work drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Specialist Contractor shall revise these drawings until agreed by all parties.

11. BUILDERS' WORK:

- 11.1. All builders' work such as the cutting of holes in walls and floors, the provision of foundations for plant and equipment, etc., will be carried out by the Main Contractor. The Specialist Contractor shall, however, be responsible for providing all information required by the Main Contractor for the correct marking-off and setting out of such work.
- 11.2. Where services pass from one fire compartment to the next, the integrity of the fire barrier shall be maintained. Unless otherwise indicated, the Main Contractor shall carry out such making good of fire compartments. The Specialist Contractor shall be responsible for ensuring that no damage is caused to services.
- 11.3. The Specialist Contractor shall include for all services expansion and flexible joints as necessary to cross building expansion joints.

- 11.4. Where applicable, details of walls and ceilings having a wet plaster finish shall be as listed in the Architect's schedules. Services in these areas shall be installed insofar as possible to alleviate the need for access. Where access is necessary, the Specialist Contractor shall be responsible for the correct indication and marking out of such access.

12. PAINTING:

- 12.1. Ferrous sheet materials shall receive a protective coating of paint at works after suitable preparation, or be treated with the manufacturer's approved corrosion-resisting metal finishing process. Any deterioration or damage to the manufacturer's protective coating during storage, installation and before hand-over shall be made good by the Specialist Contractor to the satisfaction of the Engineer.
- 12.2. Unless otherwise indicated, the Main Contractor shall be responsible for decorative painting to:-
- 12.2.1. Water storage tanks and vessels.
 - 12.2.2. Thermal insulation exposed to view, including that within plant rooms, except where protected by metallic foil or sheet, plastic film or a weatherproof finish. An undercoat and not less than two finishing coats shall be applied. Absorbent surfaces shall receive an initial coat of priming paint.
 - 12.2.3. Areas of deterioration or damage as described in clause 13.1.
- 12.3. The surfaces of all ferrous metalwork including pipework, hangers, supports, etc. which are not protected by galvanising, works-applied primer, or protective paint shall be suitably prepared and painted with one coat of zinc phosphate primer. All such surfaces, with the exception of pipework that is to be insulated, shall be finished with two coats of approved quality non-metallic paint to BS 5493. Where surfaces will be subjected to temperatures above 100°C, the finishing coat(s) shall be heat-resisting paint, and the primer normally omitted. The Contractor shall ensure that:-
- 12.3.1. Surfaces are cleaned in accordance with BS 7079 before they are painted.
 - 12.3.2. Those parts of the installation required to be left unpainted (e.g. brasswork) are so left.
 - 12.3.3. The services are correctly identified to ensure the use of approved paint of the correct colour to comply with BS 1710.
- 12.4. Unless otherwise indicated, the Main Contractor will apply, free of cost to the Contractor, the priming and finishing coats except those as detailed in clause 13.2.

13. MOCK-UPS, DEMONSTRATIONS AND SAMPLES:

- 13.1. The Specialist Contractor shall allow for the provision of mock-ups, samples and functional and operational demonstrations of all systems.
- 13.2. The Specialist Contractor shall submit samples of proposed materials to the Engineer for written approval as and when required.

14. RATIONALISATION OF SUPPLIES:

- 14.1. Items, fittings and accessories to be used in quantity shall, where practicable, be the product of one manufacturer and shall be used only for the purpose recommended by that manufacturer.

15. COMMISSIONING AND TESTING

- 15.1. The main contractor shall notify the Engineer in writing when, in their opinion, the services installation works or parts thereof are ready for testing and commissioning. The specialist contractor shall then carry out the tests. The specialist contractor shall prove to their satisfaction that all test results are in accordance with the specification. The specialist contractor shall then functionally test all installations in the presence of the Engineer and shall make all specified tests to the satisfaction of the Engineer.
- 15.2. Should the specialist's contractor's initial tests fail to demonstrate that the plant and equipment are properly installed and functioning correctly, the cause of the failure shall be investigated and adjustments as may be necessary made. The commissioning and functional demonstrations shall then be repeated to the satisfaction of the Engineer.
- 15.3. Where it is not possible at the particular time of commissioning and testing for full load conditions to be obtained or simulated, the specialist contractor shall repeat such operations of full load or simulation thereof at a time when this can be achieved.
- 15.4. Where portions of the work are commissioned and tested separately, the Specialist Contractor shall, upon Practical Completion or Completion of Section as defined in the Main Contract Conditions, demonstrate to the Engineer that all the several portions are capable of proper simultaneous operation.
- 15.5. In cases where the construction programme is such that the Specialist Contractor will need to return to the portion of the building taken over and occupied by the Employer in order to undertake testing, balancing, adjustment, etc., the Specialist Contractor shall take all necessary precautions against, and shall be responsible for, any damage caused whilst working in such areas for that purpose.

- 15.6. Subsequent to the completion of all testing and commissioning to the satisfaction of the Engineer, the specialist contractor shall operate the plant and shall demonstrate that the overall systems function correctly in accordance with the requirements of the Specification. A period of at least seven days full running and operation shall be considered reasonable for this demonstration. During this period the specialist contractor shall be responsible for the operation and maintenance.

16. PRACTICAL COMPLETION

- 16.1. Practical Completion of the specialist's contractor's works, or agreed phase or part of the works, shall not be effected until the specialist contractor has fulfilled their obligations under the Main Contract conditions and in particular demonstrated to the satisfaction of the Engineer that the following aspects are complete:-
- 16.1.1. All works to be complete other than minor snags or defects which could be reasonably completed within an agreed programme without causing disruption to the Employer's or their Agent's use of the Building or agreed part thereof. In respect of this clause, specifically but not uniquely, the employer's representative shall be the sole arbiter of what may be considered minor, reasonably completed, an agreed programme and disruption to the Employer.
 - 16.1.2. All tests and functional demonstration have been undertaken successfully
 - 16.1.3. All final copies of the Record Drawings, Schedules, Operating and Maintenance manuals and test certificates have been supplied in a format agreed to the Engineer.
 - 16.1.4. All spares, keys, tools, oils, chemicals and other materials required by the specification for the running and maintenance of the Engineering Systems as specified are to have been supplied.
 - 16.1.5. All instruction of the Employer's staff to have been satisfactorily completed in accordance with the programme for handovers agreed with the employer's representative.

17. TRAINING OF EMPLOYER'S PERSONNEL

- 17.1. Provide experienced personnel to instruct the Employer's personnel in the operation, maintenance and servicing of all of the installations. Give instructions for an appropriate period commensurate with the scale and complexity of the installations and not less than three working days before the Specialist Works are handed over.

18. SYSTEMS USED BEFORE PRACTICAL COMPLETION

- 18.1. Systems may not, without the prior written approval of the consultant engineer be used before Practical Completion.
- 18.2. Systems to be used before practical completion for the benefit of the Main Contractor and / Specialist Contractor must have all defective consumable elements (including lamps and tubes) replaced by new elements not more than seven days prior to Practical Completion.
- 18.3. No system shall be put into use prior to handover to the employer, except for testing and commissioning, unless in accordance with the following procedure:
- 18.4. Following the receipt of written instructions, the Specialist Contractor shall operate designated parts of the Works, provided that such operation is practicable and does not prejudice the Specialist Contractor's responsibilities and obligations.
- 18.5. Allow the defects liability period to commence on handover.

19. OPERATION OF SYSTEMS BEFORE THE PRODUCTION OF RECORD DRAWINGS AND/OR OPERATING AND MAINTENANCE MANUALS

- 19.1. Provide attendance, at no expense to the Employer, to put into service, operate 24 hours a day and maintain the systems to the Employer's requirements, including the provision of suitable competent labour, in the event that the Record Drawings and/or Maintenance Manuals are not available when the Works would, in the opinion of the Engineer, otherwise qualify for Practical Completion.
- 19.2. In the event of the Specialist Contractor failing to provide this service satisfactorily the Employer shall be entitled to make his own arrangements and recover the full cost through the Contract.

20. OBLIGATIONS AFTER PRACTICAL COMPLETION

- 20.1. Between the issue of a Certificate of Practical Completion and the Certificate of Making Good Defects relating to the whole or part of the Specialist Works, provide the following:
 - 20.1.1. A prompt call-back service, available at all reasonable times, to attend to any faults.
 - 20.1.2. Carry out a final test at the end of the Defects Liability Period to demonstrate to the Engineer that the Specialist Works are operating efficiently and that all components are functioning correctly.

- 20.2. Carry out all work using competent, trained personnel and except where made necessary by abuse, misuse or negligence by other than the Specialist Contractor, make no charge to the Employer.
- 20.3. Notwithstanding the foregoing paragraph, charge to the Employer the net cost of replacement of life-expired disposable parts.

21. REQUESTS FOR DEVIATION FROM SPECIFICATION:

- 21.1. Any deviation from the Specification sought by the Specialist Contractor made through the Main Contractor must be in the form of a written request and must be sanctioned in writing by the Engineer and Employer's Representative to be valid.

22. BUILDING CONTROL (AMENDMENT) REGULATIONS 2014

- 22.1. The Contractor shall include for the full implementation of the Building Control Regulations 1997 - 2014 and the Building Control (Amendment) Regulations S.I. No.9 of 2014 & S.I. No. 105 of 2014. The Contractor shall include for their attendance as required to implement the inspection plan prepared by the design team and the ongoing inspections.
- 22.2. The Contractor shall notify the design team when their works are ready for inspection, during the proposed program of works. The Contractor is advised to contact the Main Contractor to establish the proposed programme of works.
- 22.3. The Contractor shall give adequate notice for the ongoing inspection prior to the completion of any individual element of the Mechanical, Electrical and Lift Installations and shall confirm that the works are in compliance with the Building Regulations and will be complete for inspection. Any defects of workmanship, materials, performance, design of equipment, maladjustments or other irregularities which become apparent during the inspections shall be rectified at the Contractor's expense.
- 22.4. The Contractor shall ensure that sufficient time is allowed in the Main Contractor's programme for each of the ongoing inspections. Throughout the execution of the works, the Contractor shall be responsible for ensuring compliance with all relevant Contract Drawings & Specifications, Building Regulations, Safety Codes and Local Authority requirements and shall notify the Engineer of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the installation whether or not such infringement relates to the works covered in this Specification or to the associated works of others.
- 22.5. The Contractor shall provide all necessary Certificates of Compliance with regard to the requirements of the Building Regulations, the Building Control Regulations 1997 - 2014 and the Building Control (Amendment) Regulations S.I. No.9 of 2014 & S.I. No. 105 of 2014 and as requested by the Engineer.

- 22.6. In addition to and accompanying the Commencement Notice, there are two statutory assignments and three statutory certificates to be completed on-line using the Building Control Management System (BCMS), on-line system. The format for these are as per the Second Schedule, S.I. 9 2014.
- 22.7. At completion, a fourth statutory certificate is completed on-line using the Building Control Management System (BCMS) on-line system. The format for these are as per the Second Schedule, S.I. 9 2014.
- 22.8. The Preliminary Inspection Plan is a statutory document prepared by the Assigned Certifier that to be submitted to the Building Control Authority by the Employer with the Commencement Notice a minimum of two weeks and a maximum of four weeks in advance of the commencement of the works. At project completion the Inspection Plan as implemented is submitted to the Building Control Authority.
- 22.9. It is the responsibility of the Main Contractor to employ competent persons to supervise the works. The Inspection Plan shall not in any way diminish the duty of the Main Contractor to properly supervise, and any defective works, whether identified during or after the contract period, remain the sole responsibility of the Main Contractor.
- 22.10. The Main Contractor shall include with his tender submission a Method Statement and his own Preliminary Inspection Plan indicating his own inspection and supervision regime.
- 22.11. A copy of the Preliminary Inspection Plan will be included in the Architectural tender documents. The inspection requirements set out in this document do not in any way relieve, replace, or reduce the Main Contractor's duty to supervise the works.
- 22.12. COORDINATION OF TESTS, INSPECTIONS & RECORDS:
- 22.12.1. The Main Contractor shall meet and coordinate and update the Inspection Notification Framework and Preliminary Inspection Plan with the proposed construction programme and shall incorporate the agreed inspection milestones.
- 22.12.2. All elements identified in the Inspection Notification Framework are to be made available for inspection at each milestone:
- Complete,
 - Not concealed
 - Safely accessible.
- 22.12.3. The Main Contractor shall facilitate random inspections by the Assigned Certifier and / or Ancillary Certifiers as if such inspections were identified in the Inspection Notification Framework.
- 22.12.4. The Main Contractor shall provide in a timely manner all CE certificates, Declarations of Performance and test certificates for materials, products and assemblies.

22.13. ADVANCE NOTICE AND TIME FOR INSPECTIONS:

- 22.13.1. Due consideration shall be given by the Main Contractor for inspection notices. No claims for extension of time or financial claims shall be considered for delays arising out of inspection or re-inspection requirements.
- 22.13.2. The Main Contractor shall ensure advance notifications are issued with respect to works to be inspected that are identified in the Inspection Schedule. The minimum advance notice required for inspection of items of works is five working days.

22.14. RE-INSPECTIONS/FOLLOW UP INSPECTIONS:

- 22.14.1. The minimum notice required for re-inspection of items of works not complete or requiring remedial works shall be three working days.
- 22.14.2. The Assigned Certifier shall without delay notify the Main Contractor through the Contracting Authority / Employers Representative of any incomplete work at a given milestone identified in the Inspection Notification Framework.
- 22.14.3. The Main Contractor shall diligently ensure that any incomplete areas items at given milestones are completed and that such works are kept available for inspection again, or until a record of completion is furnished, as may be required by the Assigned Certifier.
- 22.14.4. The Main Contractor shall diligently ensure that any areas of non-compliance are rectified and that such works are kept available for inspection again, or until a record of rectification is furnished, as may be required by the Assigned Certifier.
- 22.14.5. The Main Contractor shall ensure all tests and certificates for materials, components and assemblies listed in the Inspection Notification Framework are undertaken in a timely way. Any test failure shall immediately be made known to the Employers Representative / Assigned Certifier; the materials/works in question shall be replaced / rectified and retested undertaken prior to proceeding with subsequent work.
- 22.14.6. It is the responsibility of the Main Contractor to coordinate and supervise the works and no claim for delay or cost shall arise from the requirement to re-inspect.

22.15. CONTRACTOR'S PROGRESS RECORDS:

- 22.15.1. The Main Contractor shall maintain progress records and inspection records prepared by him in accordance with the Method Statement submitted at tender and as set out in this document.
- 22.15.2. Contractors shall include in their tender costs for the provision of progress records as the works proceed.

22.16. METHOD OF RECORDING:

- 22.16.1. Promptly provide a copy to the Assigned and Ancillary Certifier of all progress records and inspection records prepared by the Main Contractor and the sub-contractors.
 - 22.16.2. At completion stage, the Main Contractor shall issue the Ancillary Certifier a copy of the records prepared by the Main Contractor and the sub-contractors.
 - 22.16.3. The Main Contractor shall also retain in his own central office all records prepared by them and the sub-contractors for a minimum period of six years.
 - 22.16.4. One hardcopy and softcopy of all records shall be issued five days in advance of the nominated completion date.
 - 22.16.5. The record should include evidence of the successful execution of the Main Contractor's method statement on supervision including tests, check sheets, photographs and memos. All evidence shall be indexed by location and date.
 - 22.16.6. Acceptance of such records shall not constitute approval or imply that their content has been examined.
- 22.17. Main Contractors shall submit the following documentation as part of their tender. Failure to do so may invalidate the tender:
- 22.17.1. Main Contractor's Competence Assessment
 - 22.17.2. Sub-Contractor/Specialist Competence (Ancillary Certifiers) Assessment
 - 22.17.3. Main Contractors Method Statement
- 22.18. Tenderers shall note that Practical Completion for this contract is contingent upon the successful registration of the works on the Building Control Management System.
- 22.19. Tenderers shall note that this project shall require a Prior Notification of Completion to be submitted to the Building Control Authority in advance of completion.
- 22.20. The Main Contractor shall provide four to six weeks in advance of the nominated completion date all completed and/or 'prospective' documentation and confirmations for Registration. The Assigned Certifier and the Main Contractor shall co-sign the Completion Certificate.
- 22.21. The Assigned Certifier and Main Contractor shall then lodge/upload the documentation onto the Building Control Authority system.

- 22.22. Notwithstanding any statutory duty to retain same, in advance of project completion, the Main Contractor shall issue to the Assigned Certifier a copy of all inspection records retained by the Main Contractor during the course of the Project.

23. CONSTRUCTION PRODUCTS REGULATIONS:

- 23.1. Building Regulations Technical Guidance Document Part D (TGD D) provides guidance in relation to Part D of the Second Schedule to the Building Regulations. It relates to materials and workmanship as inserted by the Building Regulations Part D Amendment 2013 (S.I. No. 224 of 2013). To ensure the quality of materials used in construction, Building Regulations Technical Guidance Document Part D requires compliance with the EU Construction Products Regulation (Regulation (EU) No. 305/2011).
- 23.2. The EU Construction Products Regulation lays down harmonised conditions for the marketing of construction products and is directly applicable in Irish law. From July 1st 2013 CE markings have been mandatory for all construction products placed on the market in the European Economic area which are covered by a Harmonised European Standard (hENs). Although other forms of certification (IAB, BBA Certs etc.) may be available for a given product or material, if a Harmonised Standard is in place then the product/material must be CE Marked and have an associated Declaration of Performance.
- 23.3. The EU Construction Products Regulations, (CPR), sets rules for placing construction products on the EU market. All Construction products placed on this market, which includes both Ireland and Northern Ireland, must comply with the CPR, irrespective of where they are manufactured. This means they must be CE marked, use harmonised standards, (hENs), to demonstrate conformity, be certified by an EU-27 notified body and have an up-to-date EU Declaration of Performance, (DoP). Reference to a BS EN on a Declaration of Performance or CE Marking is not compliant with the relevant EU Regulations.
- 23.4. To affix the CE marking to a construction product, the manufacturer is obliged to draw up a Declaration of Performance (DoP) when a construction product is covered by a harmonized standard or conforms to a European Technical Assessment. Any information about the product's performance in relation to the essential characteristics may be provided only in the form of a declaration of performance. The CE marking shall be applied to the product itself and where this should not be possible to the packaging or accompanying documents.
- 23.5. Only manufacturers or importers can place products on the market, whereas distributors, importers and manufacturers can make them available thereafter. An importer or distributor may be considered to act as a manufacturer and is thus subject to all obligations for manufacturers in cases where he places a product on the market under his name or trademark or modifies a construction product already placed on the market. Even though not expressly stated in the CPR, the DoP and all accompanying documents are considered legal documents and shall not be altered but supplied as they have been provided by the manufacturer.

- 23.6. To this end, the Contractor shall, when selecting and submitting products and equipment for use in construction works, review the manufacturer's Declaration of Performance to ensure it is suitable for their intended use and in addition shall review National Annexes and/or Standard Recommendations for guidance on appropriate minimum performance levels for specific intended uses of the proposed equipment/product.

24. ENVIRONMENTAL PRODUCT DECLARATIONS:

- 24.1. As part of the procurement and equipment submittal process the Contractor shall endeavour to select products from manufacturers who have verified environmental life cycle impacts to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts.
- 24.2. Life-cycle assessment and environmental product declarations:
- 24.2.1. Products with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the "cradle to gate".
 - 24.2.2. Product-specific Type III EPD -- Internally Reviewed. Products with an internally critically reviewed LCA in accordance with ISO 14071. Products with product specific internal EPDs which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 - 24.2.3. Industry-wide Type III EPD -- Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator. Products with industry-wide EPDs, which conform to EN 15804 or ISO 21930, and registered and published within EPD programmes which need to meet the requirements of International Standard ISO 14025 and at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the "cradle to gate".
- 24.3. Environmental Product Declarations which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
- 24.4. Product-specific Type III EPD -- Products with third-party certification (Type III), including external verification and external critical review and at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the "cradle to gate".

SECTION 2 - TECHNICAL INFORMATION

SYSTEM DESCRIPTION:

- 1.1. The following general description is intended as an overall view of the works and does not relieve the tenderer in any way from taking account of all parts of the tender documentation.
- 1.2. The scope of this contract as shown on the tender drawings and as specified in these documents consists of the supply, delivery, installation, testing and commissioning of the complete mechanical services installations for the Mains Water Tank upgrade in the Coombe Women and Infants University Hospital, Cork Street, Dublin 8.
- 1.3. The appointed Mechanical Contractor shall act as the Main Contractor and Project Supervisor Construction Stage (PSCS) and shall appoint an Electrical Contractor as a specialist domestic sub-contractor to undertake the associated electrical installation and a General Contractor as a Specialist building Sub-Contractor to undertake the associated building works.
- 1.4. The particular mechanical services design requirements are based on the following standards and recommendations;
 - 1.4.1. HTM 04-01, "The Control of Legionella, hygiene, safe hot water, cold water and drinking water systems"
 - 1.4.2. Relevant UK Department of Health Hospital Building Notes
- 1.5. The extent of the services installation is briefly as follows;
 - 1.5.1. Strip-out works to allow for mains water booster pump set modifications
 - 1.5.2. New underground incoming mains water pipework to supply new mains water break tank
 - 1.5.3. New underground cold water pipework to supply new 700 litre cold water storage tank in the Academic Centre
 - 1.5.4. New packaged plantroom to house the new mains water break tank, booster pump, pressurised cold water tank and associated controls
 - 1.5.5. New temporary mains water booster pump to supply the main hospital cold water storage tank for the duration of works
 - 1.5.6. Controls installation
 - 1.5.7. Flushing and Chlorination

1.5.8. Testing and Commissioning

- 1.6. The Contractor shall be responsible for testing and commissioning of the complete mechanical services installations and for ensuring correct handover procedures are maintained at the end of the Contract along with all health and safety, commissioning, testing, operation and maintenance documentation.
- 1.7. The Contractor shall prepare detailed coordinated installation and builders works drawings for the mechanical services and submit the drawings to the Engineer and Architect for comment prior to commencing installation work on site.
- 1.8. The Contractor shall act as the Main Coordinator for the project and take the lead in the production of services drawings as per the requirements in Section 1 of the Specification.
- 1.9. The Contractor is advised to contact to establish the proposed programme of works. The Contractor is strongly advised to visit the site prior to submitting a tender. During the visit the Contractor should familiarise themselves with the site and all necessary works including the interface and links to existing systems and permanent and temporary diversions as required.
- 1.10. The Contractors coordinated installation and builders works drawings shall be provided in a timely manner for coordination with the building structure and fabric and all other services including, electrical distribution, water services pipework and all existing and retained services.
- 1.11. The Contractor shall provide copies of the Operation and Maintenance manuals and as installed drawings to the Engineer for review and comment a minimum of one calendar month ahead of the proposed date of Substantial Completion.
- 1.12. The Contractor shall provide a detailed schedule of rates for labour and materials on which their Tender is based within one week from the date of notification to the successful appointment to the project.

2. OUTLINE PROJECT OVERVIEW:

2.1. SERVICE CONNECTIONS AND TIE-INS

- 2.1.1. The Contractor shall be responsible for identifying all existing service links at the outset of the Contract and for ensuring that adjacent areas are kept live for the duration of the Contract where applicable.
- 2.1.2. All of these existing services are to be identified and traced out by the Contractor and subsequently relocated or if remaining to be later isolated, cut off and blanked by the Contractor.

2.2. STRIP-OUT

- 2.2.1. The Contractor shall include for the stripping out and removal of all existing mechanical services which become redundant by virtue of the Contract works. The extent of stripping out shall be deemed to include all pipework, accessories, fixings, mounting brackets, plant, equipment, etc.
- 2.2.2. Where services are buried directly into elements of the building fabric which are to be retained and the removal thereof would result in excessive damage to the building fabric, those services shall be neatly cut back into the wall or floor slab so as to allow for making good of the finishes.
- 2.2.3. When stripping out redundant services the Contractor shall ensure that no unnecessary damage is caused to either the equipment and/or the building fabric which is to be retained.
- 2.2.4. The Contractor shall note that all works associated with the diversions and modifications to existing services and strip-out of mechanical services shall only take place once a project specific method statement has been submitted and approved by the Engineer and the Coombe Hospital. Shutdowns can only be for a minimum period of time and must be agreed in advance with the hospital. All works outside the actual confines of the main working areas must be completed out of hours with agreement with the hospital.
- 2.2.5. The Contractor shall be responsible for removing all redundant materials from site and disposal thereof.
- 2.2.6. The existing duty/assist/standby booster pumpset in the basement boiler house is to be removed and handed over to the Coombe Hospital. Prior to removing other redundant materials from the site, the Contractor shall advise the Coombe Hospital accordingly and allow them the opportunity to retain any items should they wish to do so.

2.3. DOMESTIC WATER SERVICES:

- 2.3.1. The Contractor shall supply, install, commission and test the water services systems as described in the following paragraph, as indicated on the drawings and as detailed in the mechanical equipment schedules.
- 2.3.2. The Contractor shall include for the installation of a new incoming mains water underground pipe from the boiler house to the new mains water break tank behind the Academic building. This pipe shall run underground inside an existing trench as detailed in the mechanical drawings
- 2.3.3. The Contractor shall include for the tie-in of the existing DHW flow/return pipework to the new boosted mains water pipework from the new mains water break tank as detailed in the mechanical drawings.

- 2.3.4. The contractor shall note that the DHW flow & return pipes are existing in a trench underground, from the boiler house to the Academic Centre. Either the hot water flow or return pipe is to be used as the new boosted mains water pipe to serve the new 700 litre cold water storage tank to be installed in the Academic Centre at roof level.
- 2.3.5. The contractor shall include for the installation of a new section of underground pipework to serve Academic Centre as detailed in the mechanical drawings.
- 2.3.6. The remaining pipework in the trench serving the Academic centre is to be isolated from the main system and left underground to eliminate any legionella risk.
- 2.3.7. The Contractor shall include for an adequate GPR survey of the underground trench areas to be exposed as identified on the drawings.
- 2.3.8. The Contractor shall include for the installation of a new boosted mains water pipe from the packaged plantroom to the hospital's boiler house. This pipe shall run underground inside an existing trench as detailed in the mechanical drawings
- 2.3.9. Underground pipes shall be MDPE and shall be installed at a minimum depth of 750mm with a 150mm sand cover and 150mm sand bed as detailed in the mechanical drawings.
- 2.3.10. The Contractor shall allow for the GPR survey and subsequent excavation and reinstating works to expose underground trench in the car park (location as per mechanical drawings) to facilitate the pulling of new pipework from boiler house to academic building.
- 2.3.11. The Contractor shall install these pipes from the boiler house to the riser inside the academic building, transitioning then from MDPE to insulated copper.
- 2.3.12. The Contractor shall install the insulated copper pipes internally through the existing storeroom to external, through the new packaged plantroom and connect them to the new mains water break tank.
- 2.3.13. A new packaged plantroom shall be installed as detailed in the mechanical specification appendix 2 and the mechanical drawings, to house the mains water tank, booster pumps and controls.
- 2.3.14. Due to its dimensions, the packaged plantroom will be constructed on site by an appointed and approved sub-contractor under the supervision of the mechanical contractor
- 2.3.15. The Contractor shall supply and install a new pressurised cold water tank inside the packaged plantroom, leaving a 32mm valved and blanked connection for future tie-in to the Academic Building's domestic water system.
- 2.3.16. The Contractor shall supply and install a new duty/assist/stand-by booster pump set inside the packaged plantroom to tie-in to the new boosted mains water external pipework, which in turn shall tie back to the underground MDPE boosted MWS pipework into the boiler house

- 2.3.17. In the boiler house, the Contractor shall transition the MDPE underground pipework to insulated copper and tie-in to the existing MWS pipework inside as detailed in the mechanical drawings.
- 2.3.18. The Contractor shall strip-out the existing duty/assist/stand-by mains water supply pump and its accessories and hand them over to the hospital for use elsewhere.
- 2.3.19. The Contractor shall supply and install a temporary mains water booster pump set to allow for the supply of mains water to the hospital's existing roof CWS tank during the duration of works.
- 2.3.20. The Contractor shall strip-out this pump and reconnect the boosted and existing MWS pipework after the commissioning stage and hand over the pump to the Hospital for use elsewhere.
- 2.3.21. Before any works are undertaken, the Contractor shall submit a detailed Method Statement through the Main Contractor for review and approval by the Engineer and the Coombe Hospital. The programme for the tie-ins must be agreed in advance to ensure that all stake holders are given adequate notice of interruptions in the water supplies so the contingency measures can be put in place.
- 2.3.22. The installation of the domestic mains water systems shall be installed and commissioned fully in accordance with the guidelines concerning the safe design and installation of hot, cold and drinking water systems as advised in UK Department of Health HTM 04-01: The control of hygiene, "safe hot water, cold water and drinking water systems" and the "Revised Guidelines on the Management of Legionnaires Disease in Ireland, September 2009 " issued by the Health Protection Surveillance Centre. The Contractor shall be deemed to be fully conversant with the requirements of these documents.
- 2.3.23. Quarter turn isolating valves will be provided on all branch distribution pipe work and at each item of sanitary ware for local isolation.
- 2.3.24. All concealed pipework will be fabricated from copper tubing to IS EN 1057. Pipework joints and branches will generally be with brazed fittings. Suitable unions will be used at all valves.
- 2.3.25. All exposed pipework shall be fabricated from chrome pipework.
- 2.3.26. All water services pipework shall be insulated with foil backed glass fibre insulation in accordance with section 3.12 of the Specification.

2.4. FIRE PROTECTION

- 2.4.1. All pipes other than non-combustible pipes in excess of 40mm diameter will be fitted with intumescent collars where they pass through fire resistant structures and the collars will have the same rating as the construction.
- 2.4.2. All pipes with diameter less than 40mm where they pass through fire resistant construction will be fire stopped using sand and cement mortar or other

proprietary fire sealant. The openings for these pipes are to be kept as small as possible.

- 2.4.3. The Contractor shall supply and install portable fire extinguishers throughout the area of the works in accordance with IS290:1986 and Amendment No. 2 1991. Fire Point signage shall also be provided to indicate all fire extinguisher locations.

2.5. COMMISSIONING:

- 2.5.1. The Contractor shall employ the specialist suppliers of the systems to commission the following:

2.5.1.1. Water Services & Pumps

2.5.1.2. Extract Fans

2.5.1.3. BMS & Automatic Controls Systems

2.5.1.4. Flushing and Chlorination

- 2.5.2. The Contractor will be required to provide commissioning certificates from the suppliers of each of the above systems.

3. DESIGN CRITERIA:

3.1. EXTERNAL DESIGN CONDITIONS:

Summer: 27 °C db 19 °C wb

Winter: -5 °C db -5°C wb

3.2. INTERNAL DESIGN CONDITIONS:

<u>Area</u>	<u>Temperature</u>	<u>Humidity</u>
Packaged Plantroom	Ambient	Not Controlled

3.3. VENTILATION:

<u>Area</u>	<u>Type:</u>
Packaged Plantroom	Roof Extract Fan & Louvres for passive ventilation

3.4. SYSTEM OPERATING TEMPERATURES/PRESSURES:

<u>System</u>	<u>Flow Temp</u> °C	<u>Return Temp</u> °C	<u>Operating Pressure</u> bar
Mains Water	10	-	4.8

SECTION 3 - STANDARD SPECIFICATION

PART 3.1 - PIPEWORK INSTALLATION

1. GENERAL:

- 1.1. The following specification covers the installation of pipework, fittings and ancillary items required to properly execute all pipe and pipe fitting work indicated on the drawings and in this Specification.
- 1.2. Where pipe sizes are referred to, these shall be taken as either the nominal bore or outside diameter, whichever is relevant to the particular tube specification.
- 1.3. The arrangement of pipework shown on the drawings shall be taken to indicate routing only. Exact arrangement shall be agreed with the Engineer on site.
- 1.4. Pipework referred to as 'concealed' shall include all pipework in chases, ducts, service shafts, partitions, ceiling voids, floors, etc. which is inaccessible, and shall not include short lengths of pipework passing through the building structure.
- 1.5. All pipework systems shall be entirely suitable for the pressures and temperatures of the systems and for operation with the particular fluids conveyed.
- 1.6. Tube manufacturer's documentation covering material specifications shall be made available on site, for inspection by the Engineer.
- 1.7. Installation of piped services in ducts shall comply with the requirements of BS 8313, 'Accommodation of Building Services in Ducts'.
- 1.8. Pipework shall be neatly installed to follow the contours of the building, with offsets where required, and to give maximum headroom, not obstructing windows and doorways, and shall fit in with the work of other contractors. All pipe drops shall be plumbed. No joints shall be formed in the thickness of walls, floor or ceiling. Joints in inaccessible positions shall not be accepted. Pipework which, in the opinion of the Engineer, is misaligned, unsightly or otherwise below standards of first class workmanship shall not be accepted.
- 1.9. All pipework, valves, fittings and equipment forming a piping installation shall be erected so that it can be dismantled where it is accessible for repair and replacement. The couplings shall be as specified for each service contained elsewhere in this section of the specification or suitably approved couplings and fittings as manufactured by "Grinnell" or equal.
- 1.10. Piping systems shall be arranged for proper circulation and venting and so that drainage may be effected through full-bore drain valves at main headers to assist system flushing.

- 1.11. Unless otherwise indicated, steam and condensate mains shall be graded to fall in the direction of flow. The minimum gradient shall be 1 in 250.
- 1.12. Unless otherwise indicated, horizontal drain pipework from fan coil units, etc. shall be run to fall at a minimum gradient of 1:100.
- 1.13. Overflows and warning pipes shall be fitted so that they discharge in obvious positions.
- 1.14. Reductions in bore of vertical pipework shall be made with concentric reducing fittings and reductions in bore of horizontal pipework shall be made with eccentric reducing fittings. Purpose-made reducers will not be accepted. Branch welds shall be at least one size smaller than mains size to ensure the pipe remains intact.
- 1.15. Branches on steel and copper pipes up to and including 50 mm shall be reamed and belled before branches are welded or brazed to mains. Branches on pipes 65 mm and over shall be trimmed and shaped to receive branch pipes before welding or brazing to mains. The cut out of the mains shall be the full bore of the branch pipe. Branch welds shall be at least one size smaller than mains size to ensure that pipe remains intact.
- 1.16. Where flanged joints in butt-welded steel pipework are introduced to facilitate erection, their number shall be kept to a minimum.
- 1.17. Pipe flanges joining flanged valves, fittings or equipment shall be in line with and parallel to the adjoining flange, correctly spaced for the accommodation of gaskets, and all bolts shall be proved easy entry and fit before flanges are bolted together.
- 1.18. Where systems comprise more than one type of pipe and conversions are necessary for the connection of one with another, or where such pipes connect to equipment dimensioned differently, the Contractor shall provide and install the required adaptations.
- 1.19. Unless otherwise indicated, all flow and return headers shall be provided with a spare flanged connection, sealed with a blank flange, of a size not less than the largest circuit connection to the header.
- 1.20. In the course of installation, plugs shall be used to prevent ingress of dirt. Should a stoppage occur due to this cause or should any pipework be found both unprotected and unattended, the Contractor shall clean out the pipework at his own expense.
- 1.21. The Contractor shall ensure that pipework and fittings are so stored that no corrosive or physical damage will occur.

- 1.22. The Contractor shall ensure that metallic pipework systems are earthed by the electrical contractor prior to insulation.

2. PIPEWORK AND FITTINGS:

2.1. GENERAL:

- 2.1.1. Fittings shall be the same size as the tubes and pipes to which they are connected. The use of bushes is not acceptable.
- 2.1.2. Bends shall be long radius and all tees swept pattern, unless this precludes the natural venting of pipework.
- 2.1.3. Flanges shall comply with ISEN 1092 Part 3 and shall be compatible with the materials, temperature and pressure of the system. Bolts shall be capable of withstanding the service conditions and shall be the correct size for the flange as indicated in the appropriate flange tables.
- 2.1.4. Gaskets shall be to BS 3063 or IS EN 1514 as applicable, of a grade and thickness suitable for the temperature, pressure and operating conditions of the service.
- 2.1.5. Thread compound shall be PTFE tape to BS 6956 or BS 7786 as appropriate, and shall be suitable for use with the system and service conditions.

2.2. HEATING AND CHILLED WATER:

- 2.2.1. LTHW heating and CHW pipework up to 150mm shall be fabricated from black steel tube to BS 1387 or equivalent, ungalvanised medium grade.
- 2.2.2. MTHW heating and HTHW pipework up to 150 mm shall be fabricated from seamless black steel tube to BS 1387 or equivalent, ungalvanised heavy grade.
- 2.2.3. Pipework 200mm to 450mm shall be to ISEN 10216 Part 1 and 10217 Part 1 and be of hot finished electric resistance welded construction from steel with minimum tensile strength of 360N/mm², unless indicated as seamless.
- 2.2.4. Fittings shall be to IS EN 10253 or equivalent, though in locations where LTHW and CHW pipework up to and including 50 mm is exposed, BSP screwed connections may be permitted to BS 143 and 1256 with the approval of the Engineer. Screwed joints will not be permitted on MTHW and HTHW pipework.
- 2.2.5. Cold feeds and open vents shall be run in copper tube as specified for water services pipework.
- 2.2.6. Suitable spherical seated unions shall be used on LTHW and CHW pipework up to and including 50 mm for connection to valves and equipment and to permit easy dismantling of pipework.

2.2.7. On LTHW and CHW pipework 65 mm and above, and on all MTHW and HTHW pipework, flanges shall be used to ISEN 1092 Part 3 as appropriate for the temperatures and pressures specified.

2.2.8. Proprietary grooved pipe jointing systems using elastomeric seal rings may be used up to a maximum temperature of 95°C and a maximum pressure of 9.5 bar with the approval of the Engineer, and shall be suitable for the temperature, pressure and operating conditions of the service. Manufacturer's recommendations on pipe wall thickness, methods of groove forming, groove dimensions, seal materials and limiting operational loads shall be followed. Piping ends shall be within the recommended tolerances and shall be free from burrs and distortion.

2.3. FUEL OIL:

2.3.1. Fuel oil pipework, including vent pipe oil fill line, oil feed line to burner and connection to sludge cock, shall be fabricated from black steel tube to BS 1387, ungalvanised medium grade, except for pipes permanently concealed which shall be heavy grade.

2.3.2. Underground fuel oil pipework shall be API-5L-grade B sched. 40 seamless pipe with polyethylene coating. Any damage caused to polyethylene coating during installation shall be repaired per manufacturer's requirements.

2.4. DOMESTIC WATER SERVICES:

2.4.1. Domestic hot and cold water and above ground mains water pipework shall be fabricated from half hard copper tubing to IS EN 1057.

2.4.2. Copper fittings shall be lead-free solder ring capillary type to IS EN 1254, though in locations where pipework up to and including 54 mm is exposed, compression fittings to IS EN 1254 may be permitted with the approval of the Engineer. Fittings shall be resistant to dezincification and shall be fully compatible with the copper tubing.

2.4.3. Suitable unions shall be used for connection to valves and equipment and for dismantling of pipework up to and including 54 mm. Over 54 mm, flanges shall be used to ISEN 1092 Part 3.

2.4.4. Run-outs and dead legs to sanitary fittings shall be run generally in the form of a 'float', which shall be blanked at the end and capped. The Contractor shall include for connecting to sanitary fittings unless otherwise indicated.

2.4.5. Where indicated, exposed external water services pipework shall be trace heated in accordance with Part 3.12 of this Specification.

- 2.4.6. Proprietary PVC-C piping systems may be used for domestic water services within buildings only with the prior approval of the Engineer. Pipework shall be suitable for the operating conditions and shall be installed in accordance with manufacturer's instructions.
- 2.4.7. Underground mains water pipework shall be medium density SDR11 polyethylene pipe to IS 135. Joints shall be electro-fusion type and branches shall be made using an electro-fusion type tapping tee or tee-piece with reducer. The Contractor shall be responsible for the correct installation of the pipework and fittings which must be strictly in accordance with the manufacturer's published installation practice. The manufacturer's representative shall demonstrate the use of the 110 V electro-fusion machine on site prior to installation.
- 2.5. FIRE SAFETY:
 - 2.5.1. Fire safety systems shall comply with BS 5306, as appropriate, and shall be approved by the local fire fighting and water authorities as necessary.
 - 2.5.2. Fire safety pipework shall be as indicated for mains water pipework.
 - 2.5.3. Proprietary grooved pipe jointing systems shall comply with the requirements as indicated for heating and chilled water pipework.
- 2.6. STEAM AND CONDENSATE:
 - 2.6.1. The following specification covers steam installations at working pressures up to and including 10.3 bar.
 - 2.6.2. Pipework up to and including 100 mm shall be fabricated from ungalvanised ERW carbon steel tube to BS 1387 heavy grade or equivalent.
 - 2.6.3. Tubes 150 mm or over, up to and including 300 mm, shall be fabricated from ungalvanised seamless carbon steel tube to ISEN 10216 Part 1 and ISEN 10217 Part 1 or equivalent, with minimum wall thickness 6.3 mm. Where, for availability, tube wall thickness exceeds 6.3 mm, the Engineer shall be informed, so that flexibility calculations can be checked.
 - 2.6.4. Steam mains air venting points, pipework between mains and air vents, and air vent tailpipes shall be as specified above for pipework up to and including 100mm. Overflow pipes from condensate receivers, boiler feed tanks, etc. and escape pipes from safety valves on boilers and steam mains shall be as specified above for pipework up to and including 100mm or for pipework 150mm to 300mm, according to their size.
 - 2.6.5. Fittings shall be to IS EN 10253 or equivalent, though in locations where pipework up to and including 50 mm is exposed and the maximum pressure does not exceed 3.5 bar, BSP screwed connections may be permitted to BS 143 and 1256 with the approval of the Engineer.

- 2.6.6. Where screwed, joints in pipework up to and including 40 mm shall be taper/parallel type and in 50 mm shall be taper/taper type, and pipe fittings shall be wrought steel to IS EN 10241, heavy grade.
- 2.6.7. On pipework conveying steam at up to 3.5 bar, unions may be used up to and including 50 mm for connection to valves and equipment and to permit easy dismantling of pipework and shall be bronze cone seated, screwed BSP to BS 143 and 1256. All other connections shall be flanged to ISEN 1092 Part 3, as appropriate for the operating temperature and pressure.
- 2.6.8. Gaskets between flanges shall be metallic type with graphite filling.
- 2.7. MANUFACTURED AND NATURAL GAS:
 - 2.7.1. The following specification covers pipework between the primary meter and point of gas usage for non-domestic installations and for domestic installations where pipework exceeds 25 mm, at pressures up to 5 bar.
 - 2.7.2. Installation, support, protection, pipework, joints and fittings shall be in accordance with IS 820 and IS EN 1775.
 - 2.7.3. Working Pressures up to 75 mbar:
 - 2.7.3.1. Pipes in external ducts, up to and including 67 mm, may be copper to IS EN 12449, or polyethylene as specified below for working pressures up to 2 bar (below ground).
 - 2.7.3.2. Pipes above ground (excluding riser pipes in high-rise buildings) up to and including 42 mm shall be copper to IS EN 12449.
 - 2.7.3.3. Fittings in copper pipework shall be capillary type to IS EN 1254.
 - 2.7.3.4. Flanges in copper pipework joining flanged equipment connections shall be brazing metal of size compatible with equipment connection and shall be brazed to pipe.
 - 2.7.4. Working Pressures up to 2 bar (Below Ground):
 - 2.7.4.1. Buried pipework and pipework in external ducts shall be medium density SDR11 polyethylene to ISEN 1555 Part 1-5
 - 2.7.4.2. Where flanges in polyethylene pipework are necessary for connecting to valves, equipment, steel pipes, etc., connections shall be made using electro-fusion polyethylene flange adaptors in conjunction with NP16 back-up rings and Buna-N gaskets.

- 2.7.4.3. Fittings in polyethylene pipework shall be to ISEN 1555 Part 1-5. Joints in polyethylene pipework shall be electro-fusion type. The Contractor shall be responsible for the correct installation of the pipework and fittings which must be strictly in accordance with the manufacturer's published installation practice. The manufacturer's representative shall demonstrate the use of the 110 V electro-fusion machine on site prior to installation.

2.7.5. Working Pressures from 75 mbar up to 5 bar:

- 2.7.5.1. For working pressures over 75 mbar and up to 5 bar, pipes above ground up to and including 150 mm shall be ungalvanised black steel to BS 1387, medium grade, or equivalent. Pipes over 150 mm shall be ungalvanised carbon steel to ISEN 10217 Part 1 and ISEN 10216 Part 1 or equivalent, with wall thickness 5.4 mm up to and including 250 mm and 5.6 mm for 300 mm.
- 2.7.5.2. For working pressures over 2 bar and up to 5 bar, buried pipes and pipes in external ducts up to and including 150 mm shall be ungalvanised black steel to BS 1387, heavy grade, or equivalent. Pipes over 150 mm shall be ungalvanised carbon steel ERW to BS 3601 Grade 360 or equivalent with wall thickness 6.3 mm up to and including 300 mm.
- 2.7.5.3. Steel pipework shall have welded joints, except where flanges are necessary for connecting to valves, equipment, etc.
- 2.7.5.4. Fittings in steel pipework shall be to IS EN 10253 or equivalent.
- 2.7.5.5. Flanges shall be raised face slip-on boss type to ISEN 1092 Part 3 as appropriate.
- 2.7.5.6. Gaskets between flanges shall be spiral wound metallic type with non-asbestos filling.

3. VALVES:

3.1. GENERAL:

- 3.1.1. Valves shall be entirely suitable for the systems into which they are to be fitted. Valves are generally indicated on the drawings, but the Contractor shall ensure that a sufficient number of valves are included to enable each installation to be properly maintained in sections.
- 3.1.2. As far as is possible the type and appearance of valves shall be consistent throughout the whole of the installation in order to rationalize stock holding of spares.

- 3.1.3. All valves shall have the manufacturer's name, material designation, pressure rating and size clearly marked on the outside of the body. In addition, all globe and check valves shall have arrow indication of flow direction and three-way valves shall have the position of the ports clearly engraved on the square end of the plug.
- 3.1.4. Isolating valves shall be fitted such that each circuit of each installation and each item of equipment may be isolated. Isolating valves on LTHW, MTHW, HTHW and steam systems shall be fitted with heat insulated handwheels where required.
- 3.1.5. Regulating valves shall be fitted on the return connection from each item of heating and cooling equipment and on each major branch in plant rooms and elsewhere as required to ensure proper balancing of water flow rates.
- 3.1.6. Commissioning sets shall be provided and installed as shown on the drawings and where required for satisfactory commissioning, operation and maintenance. Measuring devices shall provide flow measurement accuracy to within $\pm 5\%$ under the design service conditions and shall be suitable for the application such that the differential pressure produced is consistent with achieving measurement accuracy. Measuring devices shall be installed with a minimum of ten diameters of straight pipe upstream and five diameters downstream.
- 3.1.7. Safety and relief valves shall meet the requirements of the appropriate BS for the boiler, calorifier or pressure equipment to which they are connected, and shall be suitable for the operating conditions of the system. Discharge and waste pipes shall terminate at visible and safe positions to be agreed with the Engineer and connections to drains shall be provided where required.
- 3.1.8. Ball float valves shall be of the delayed action type in tanks or items of equipment and plant supplied with boosted water, and where water meters are used to measure water quantity.
- 3.1.9. Valves shall be easily accessible. Where necessary extended valve spindles shall be provided to facilitate access. Also, valves fitted in horizontal pipework or to equipment with horizontal connections shall be installed with the valve spindle vertically upwards unless otherwise agreed with the Engineer. Check valves shall be installed in accordance with manufacturer's recommendations.
- 3.1.10. Where modifications or extensions to existing services are to be carried out, all valves which are to be removed and re-fixed shall be overhauled thoroughly, with glands and seals renewed, all to the satisfaction of the Engineer.
- 3.1.11. On completion of the works, the Contractor shall supply and hand over to the Employer a sufficient quantity of loose keys for plug and lockshield valves.

3.2. HEATING AND CHILLED WATER:

3.2.1. LTHW Heating and CHW:

- 3.2.1.1. Isolating valves up to and including 50 mm, other than those for radiators, shall be full bore ball valves with bronze body, brass ball, PTFE seat and ends screwed BSP. Isolating valves 65 mm and over shall be wafer or lugged type butterfly valves with cast iron body, EPDM seat, nylon coated ductile disc and shall be lever operated up to 150 mm and gear operated above 150 mm. Lugged type butterfly valves shall be used adjacent to equipment and wafer type elsewhere.
- 3.2.1.2. Check valves up to and including 50 mm shall be bronze swing type to BS 5154, with ends screwed BSP, and 65 mm and over shall be cast iron swing type with flanged ends to BS 12334 or wafer type, spring loaded, to fit between flanges.
- 3.2.1.3. Regulating valves shall be variable orifice double regulating globe type to BS 7350, ISEN 13789 or and BSEN / ISEN 12288 : 2003 as applicable, and shall incorporate a facility to prevent valves being opened beyond preset limits. Valves up to and including 50 mm shall be with bronze body and threaded ends and 65 mm and over shall be with cast iron body and flanged ends.
- 3.2.1.4. Flow measuring/regulating sets shall comprise fixed orifice plate to BS 1042 and isolating valve on flow pipe with double regulating globe valve on the return pipe. Alternatively, a combined or integral measuring/regulating device comprising fixed orifice plate coupled to double regulating valve installed on the return pipe with an isolating valve on the flow pipe may be used. Regulating valves shall be to BS 7350, ISEN 13789 or BSEN / ISEN 12288 : 2003 as applicable. Valves up to and including 50 mm shall be with bronze body and threaded ends and 65 mm and over with cast iron body and flanged ends. Required flow rates shall be achieved with valve positions more than 25% open.
- 3.2.1.5. Radiator wheel and lockshield valves shall comply with BS 2767 and radiator thermostatic control valves shall comply with BS 7556.
- 3.2.1.6. Float operated valves for feed and expansion tanks shall be to BS 1212 of a size and type to suit the duty, and shall be arranged to shut off when the tank contains 150 mm depth of water. Floats shall be to BS 1968 or BS 2456, as appropriate.
- 3.2.1.7. Automatic balancing valves suitable for installation at terminal units shall be of DZR material, supplied complete with strainer and a factory fitted flow rate control cartridge, pre-set to give the required flow rate.

3.2.2. MTHW and HTHW Heating:

- 3.2.2.1. Isolating valves up to and including 50 mm shall be ball valves to BS 5159 or BSEN 17292 as applicable with carbon steel body, stainless steel ball, PTFE seat and S.W. or screwed BSP ends. Isolating valves 65 mm and over for MTHW and HTHW systems shall be steel gate type to BSEN 10434.
- 3.2.2.2. Check valves up to and including 50 mm shall be bronze swing type to BS 5154 and BSEN / ISEN 12288 : 2003 with integral seat and ends screwed BSP. Check valves over 65 mm shall be steel swing type to BS 1868 with flanged ends or wafer type, spring loaded, to fit between flanges.
- 3.2.2.3. Regulating valves and flow measuring devices shall be as specified for LTHW and CHW systems except that bodies of valves 65 mm and over shall be carbon steel.

3.3. FUEL OIL:

- 3.3.1. Valves for fuel oil services shall comply with the requirements of BS 799.

3.4. DOMESTIC WATER SERVICES:

- 3.4.1. Valves shall be resistant to dezincification and shall be fully compatible with the pipework system of which they form part.
- 3.4.2. Isolating valves up to and including 28 mm shall be ball valves with brass body, chrome plated ball, PTFE seat and compression ends. Isolating valves over 28 mm and up to 54 mm shall be 3-piece bronze ball type with PTFE seat and solder ends. Isolating valves over 54 mm shall be wafer type butterfly valves with cast iron body and EPDM seat, nylon coated ductile disc, lever or gear operated.
- 3.4.3. Stopcocks up to 54 mm shall be bronze to BS 1010 with copper compression couplings. Stopcocks on underground mains pipework shall be 'Instantor' Ref 150.
- 3.4.4. Float operated valves for cold water tanks shall be to BS 1212 of a size and type to suit the duty. Floats shall be to BS 1968 or BS 2456, as appropriate. Where required, silencers shall be fitted on float valves.
- 3.4.5. Groups of fittings shall be capable of being isolated so that the installation can be maintained in sections, and where indicated, the Contractor shall supply and fit screwdriver operated ball valves in nickel plated forged brass at each individual item of sanitary ware.

- 3.4.6. Regulating / Balancing Valves fitted on H.W.S. return pipe from groups of fittings shall be thermostatically operated (PN16, Series B, TA-Therm or equal) with the following range:

16 Bar @ 90°C
35°C to 65°C setting range
Factory set at 55°C
Female threaded ends to BS21 (ISO7)

3.5. FIRE SAFETY:

- 3.5.1. Valves shall comply with BS 5306, as appropriate.

3.6. STEAM:

- 3.6.1. Isolating valves up to and including 50 mm shall be globe type with bronze body, screwed BSP end connections and stainless steel internals. Isolating valves over 50 mm shall be globe type, bellows sealed, with non-rising handwheel and open/closed indicator, bellows manufactured from titanium stabilised stainless steel. SG iron bonnet and cast iron bodies to design condition PN 16; SG iron bonnet and bodies to design condition PN 16/PN 25; steel bonnet and bodies to design condition PN 40.
- 3.6.2. Check valves up to and including 50 mm shall be bronze swing type to BS 5154 and BSEN / ISEN 12288 : 2003 with integral seat and ends screwed BSP. Check valves over 65 mm shall be steel swing type to BS 1868 with flanged ends ASA 150 or wafer type to fit between flanges.
- 3.6.3. Vacuum-breaking valves shall have bronze bodies and shall be spring-loaded ball type.

3.7. CONDENSATE:

- 3.7.1. Isolating valves up to and including 50 mm shall be 3-piece ball type with carbon steel body, ends screwed BSP, stainless steel ball, cap and stem, and PTFE seat. Isolating valves 65 mm and over shall be 3-piece ball type with carbon steel body, flanged ends, stainless steel ball, cap and stem, and PTFE seat.
- 3.7.2. Check valves up to and including 50 mm shall be mushroom pattern with gunmetal body and ends screwed BSP. Isolating valves 65 mm and over shall be wafer type having bronze body, to fit between flanges to a maximum body design of PN 16.
- 3.7.3. Vacuum breaking valves shall have bronze bodies and shall be spring loaded ball type.

3.8. MANUFACTURED AND NATURAL GAS:

- 3.8.1. Isolating valves in polyethylene pipework, up to and including 50 mm, shall be full bore ball type with brass-body, brass ball, PTFE seat and ends screwed BSP. Valve ends shall be fitted with metal x polyethylene transition couplings, complete with liner to support polyethylene pipe and designed to accept anti-shear sleeve.
- 3.8.2. Isolating valves in polyethylene pipework 65mm and over, up to and including 200 mm, shall be butterfly lugged pattern type with cast iron body, Buna-N liner, stainless steel shaft and ductile iron disc. Valves shall be lever operated up to 150 mm, and gear operated above 150 mm.
- 3.8.3. Isolating valves in steel and copper pipework up to and including 50 mm shall be full bore ball type as specified above for isolating valves in polyethylene pipework, without transition couplings.
- 3.8.4. Isolating valves in steel and copper pipework 65 mm and over shall be as specified above for isolating valves in polyethylene pipework, between steel flanges.
- 3.8.5. Valves for fire rated enclosures up to and including 50 mm shall be fire-safe ball type with carbon steel body, graphite reinforced anti-static stem seat, floating solid polished ball, reinforced PTFE seat, ends screwed BSP, and shall be fire certified to BSEN 10497. Valves 65 mm and over shall be fire-safe, lugged, double offset butterfly type with carbon steel body, PTFE seat and secondary metal seat, fire certified bi-directional to BSEN 10497.
- 3.8.6. Automatically closing valves and/or vent valves operated from gas, fire or smoke detection systems shall be to BS 7461 and IS EN 161, operated by solenoid or electro-hydraulic actuator for fast or slow opening, as appropriate.

4. ANCILLARY ITEMS:

4.1. PIPE SUPPORTS:

- 4.1.1. All pipe supports, hangers and brackets required to support and control the movement of pipework shall be supplied and erected by the Contractor and shall be fixed to the building structure independent of plant and equipment. The Contractor shall obtain the approval of the Engineer of the type and spacing of the supports, hangers and brackets prior to erection.
- 4.1.2. Pipework shall be supported adequately and in such a manner as to permit free movement due to thermal expansion and contraction. Where pipes are thermally insulated the insulation shall be carried through the support. Vapour barriers shall not be pierced or damaged.

- 4.1.3. Supports for suspended pipework up to 150 mm shall be one-piece steel clip type on threaded steel rod. Supports on hot pipes shall be without rubber caps. For suspended pipework over 150 mm, supports shall be purpose-made in mild steel, with dimensions as required by BS 3974. Spring type hangers shall be fitted where required.
- 4.1.4. All parts of the supports in contact with copper pipework shall be of gunmetal or copper construction or the copper pipework shall be separated from steel supports by a layer of asbestos-free jointing material or by a 0.8mm layer of brass plate.
- 4.1.5. All sharp edges and cut ends on pipe supports, brackets, etc. shall be suitably protected.
- 4.1.6. Pipework shall be supported at a change in direction unless other agreed with the Engineer. Pipework supports shall be arranged as near as possible to the joints, and the distance between pipe supports measured along straight runs shall not exceed the following:-

<u>Nominal</u> (mm)	<u>STEEL PIPEWORK</u>		<u>Vertical</u> Bare and Insulated
	<u>Horizontal</u> Bare	<u>Insulated</u>	
15	1.8m	1.8m	2.4m
20	2.4m	2.4m	3.0m
25	2.4m	2.4m	3.0m
32	2.7m	2.4m	3.0m
40	3.0m	2.4m	3.7m
50	3.0m	2.4m	3.7m
65	3.7m	3.0m	4.6m
80	3.7m	3.0m	4.6m
100	4.0m	3.0m	4.6m
125	4.5m	3.7m	5.5m
150	5.5m	4.5m	5.5m
200	8.5m	6.0m	8.5m
250	9.0m	6.5m	9.0m
300	10.0m	7.0m	10.0m

<u>Nominal</u> (mm)	<u>COPPER PIPEWORK</u>		<u>Vertical</u>
	<u>Bare</u>	<u>Insulated</u>	<u>Bare and Insulated</u>
15	1.2m	1.2m	1.8m
22	1.2m	1.2m	1.8m
28	1.8m	1.5m	2.4m
35	2.4m	1.8m	3.0m
40	2.4m	1.8m	3.0m
54	2.7m	1.8m	3.0m
67	3.0m	2.4m	3.7m
76	3.0m	2.4m	3.7m
108	3.0m	2.4m	3.7m
133	3.7m	3.0m	3.7m
159	4.5m	3.7m	3.7m

4.2. ANCHORS:

- 4.2.1. Anchors shall be installed as shown on the drawings. Anchors shall generally be fabricated from 100 mm x 50 mm channel iron, solidly fixed to the building structure. Steel pipe shall be fixed to these anchors by 38 mm x 6 mm steel saddles, shaped to the pipe circumference and bolted to the anchor channels using 13 mm bolts and locknuts. Saddles to copper pipe shall be fabricated from 25 mm copper pipe flattened on an anvil and bolted as before to the channels and brazed to the pipe.

4.3. SLEEVES:

- 4.3.1. Where pipes pass through walls, floors and ceilings the Contractor shall provide suitable sleeves to be built in by the Main Contractor unless otherwise directed by the Engineer. Gaps around pipes shall be sealed using a suitable mastic for low temperature pipes, or silicone rubber for high temperature pipes.

4.4. WALL AND FLOOR PLATES:

- 4.4.1. Heavy duty chrome plated floor or wall plates of proprietary manufacture shall be fitted to all pipework where it passes through walls or floors and is exposed to view. Plastic wall and floor plates will not be accepted. Samples of plates shall be submitted for the approval of the Engineer prior to fixing.

4.5. EXPANSION DEVICES:

- 4.5.1. Wherever possible, advantage shall be taken of changes in direction of pipework to absorb expansion. Unless otherwise indicated, provision shall be made for expansion in straight runs by means of expansion loops, or by articulated or axial bellows type compensators, where indicated on the drawings and/or where required.

- 4.5.2. Expansion loops shall be of the 'U' type, fabricated from welding bends in the case of steel pipe and fire set brazed bends in the case of copper pipe. Expansion loops shall be designed to a limiting combined thermal and pressure stress of 70 N/mm².
 - 4.5.3. Expansion joints shall be provided with screwed or flanged ends as appropriate. They shall incorporate internal liners if required and shall be manufactured from a corrosion-resistant steel, or other approved material appropriate for the duty, and designed to withstand the test pressure of the system.
 - 4.5.4. Expansion joints shall be provided with guides to ensure that all movements are taken up in the designed manner and shall be installed in accordance with the manufacturer's recommendations.
 - 4.5.5. Where there may be significant differential movement between common condensate mains and steam trapping set outlets, i.e. where steam main drain points are remote from anchors, the connecting condensate pipework shall incorporate a suitable length of steam-compatible flexible stainless steel hose for expansion compensation.
 - 4.5.6. Measures shall be taken to prevent the movement of pipework damaging thermal insulation. Supports and guides shall be arranged to ensure that movement is taken up in the manner intended.
 - 4.5.7. Adequate provision shall be made at all connections to equipment and appliances to avoid stress due to contraction and expansion.
- 4.6. STRAINERS:
- 4.6.1. Strainers shall be installed to protect heat exchange apparatus, automatic control valves, meters and other sensitive fittings or circuits as indicated. Strainers shall be 'Y' pattern, unless otherwise indicated, suitable for the pressures and service of the piping system in which they are to be installed. Strainer bodies for line sizes up to 50 mm shall be of bronze to IS EN 1982, and otherwise of cast iron to IS EN 1561 or, on MTHW, HTHW and steam systems, of cast steel. Strainer pressure ratings shall be at least 150% of maximum service pressure in the application.
- 4.7. STEAM TRAPPING SETS:
- 4.7.1. Steam trapping sets draining steam lines or steam-using equipment shall each comprise an isolating valve, a steam trap leak detector, a steam trap and strainer or separator, a check valve and a stop valve; in that order.

- 4.7.2. Steam trap leak detectors shall have ends screwed female BSP thread. Leak detectors' sensor connections shall face outwards for access, whether steam trapping sets run to right or left of steam line drain pockets, or equipment condensate outlets. Leak detectors and steam traps shall be installed in close proximity to each other.
- 4.7.3. Steam traps shall be stainless steel thermodynamic type incorporating strainer, or a type suitable for draining a particular piece of equipment, with separate strainer.
- 4.8. STEAM PRESSURE REDUCING SETS:
 - 4.8.1. Steam pressure reducing sets shall comprise a steam-line drain pocket with steam trapping set, an isolating valve, strainer, pressure gauge, reducing valve, stop valve, safety valve and pressure gauge; in that order, and shall be fitted with a valved bypass where necessary. The bypass valve shall have a Kv value similar to the reducing valve.
 - 4.8.2. Pressure regulators shall have stainless steel seat and trim and SG iron, cast steel or bronze body, ends screwed BSP or flanged on sizes 15 mm to 25 mm and flanged on sizes greater than 25 mm. Pressure regulator shall have remote sensor control if so recommended by the manufacturer.
 - 4.8.3. Safety valves shall be full-lift type cast iron, with open type easing gear, and ends flanged to ISEN 1092 Part 3 as appropriate.
 - 4.8.4. Steam trapping sets shall be as specified in clause above.
 - 4.8.5. Strainers shall be installed lying on their side, and shall be fitted with blowdown cocks.
- 4.9. HOT AND COLD WATER MIXING VALVES:
 - 4.9.1. Unless otherwise indicated, thermostatically operated mixing valves shall be of bronze or brass construction with chromium plated finish and shall be equipped with a back-plate for wall fixing.
 - 4.9.2. Each mixing valve shall have a control thermostat capable of providing a constant mixed water temperature under the available hot and cold water pressures and of closing down the hot water inlet within 5 seconds in the event of the cold water failing. The capacity of each individual shower mixing valve shall be a minimum of 4.5 litres/min.
 - 4.9.3. Each mixing valve shall be provided with a temperature regulating handle or knob permitting regulation of the mixed water up to a maximum of 45°C. Means shall be provided for varying the maximum settings and these shall be tamperproof. The valves shall also have provision for controlling the maximum rate of outlet flow. An isolating valve and strainer shall be provided on the hot and on the cold supply to each mixing valve.

- 4.9.4. Thermostatically operated mixing valves serving groups of showers shall be capable of providing a minimum of 4.5 litre/min simultaneously to each shower and be provided with means of locking the regulating handle to prevent unauthorised interference. The water inlets shall be provided with chromium-plated check valves.

4.10. AIR VENTS:

- 4.10.1. Devices for air venting shall be provided where shown on the drawings and at all high points in the pipework distribution systems. They shall comprise an air bottle, a stop valve and a tail pipe and shall be installed at the highest points of the sections which they are intended to vent.
- 4.10.2. Automatic air vents, suitable for the system pressure and temperature, shall be installed where indicated. Each automatic air vent shall be controlled by a lock-shield valve. Air release pipes shall be run to discharge at the nearest suitable visible point.
- 4.10.3. Vapour escape pipes from safety valves on steam boilers and steam lines shall be led to atmosphere and shall terminate in a silencing-type exhaust head fitted with a copper drain pipe to ground.
- 4.10.4. Vent pipes from condensate receivers, boiler feed tanks, etc., under atmospheric pressure, shall be led to atmosphere and shall terminate in a swan neck fitted with a wire balloon or proprietary exhaust head fitting.
- 4.10.5. Air venting devices and any air release pipes installed in exposed positions where freezing is likely to occur shall be insulated.
- 4.10.6. All air vents shall be piped to a safe location and discharge without causing damage.

4.11. DRAINS:

- 4.11.1. Drain cocks, not less than 15 mm, with hose connections, shall be fitted at low points in the pipework distribution systems and local to items of equipment and headers.
- 4.11.2. Drain valves, shall be fitted to facilitate flushing and cleaning of pipework where indicated on the drawings and where required. Drain valves shall be bronze lockshield globe or gate valves to BS 5154 and BSEN / ISEN 12288 : 2003, with hose union connector. Drain valves shall be fitted to common flow and common return lines and shall be of the same size as the largest pipe size of any sub-circuit. Additionally, at intervals not exceeding 100m, an isolating valve immediately preceded by a line size drain valve, shall be included on all circuit pipework.

4.11.3. Steam and condensate pipework shall be provided with drain pockets spaced 30 to 45m apart. Drain pockets shall be of the side outlet type, with bottom opening blank-flanged, and side outlet situated 100 mm above the bottom of the pocket to minimise the possibility of scale blocking the drain pipe. Drain pockets for steam mains up to 100 mm shall be steam main size, and for steam mains over 100 mm shall be half steam main size but not less than 100 mm. Drain pocket length shall be at least 1½ times the steam main diameter, but not less than 254 mm, measured from the bottom of the main. Blank flanges at bottoms of drain pockets shall have an outlet for drainage by a manually operated valve, for use during drain-down or supervised warm-up of steam mains.

4.11.4. Drain valves or cocks shall be lockable except where prohibited by the local water authority.

4.12. TEST POINTS:

4.12.1. Generally self-sealing test points shall be provided on all secondary headers, heating and cooling piping main branches, each port of each automatic control valve, inlet and outlet of each heater and cooler battery or terminal unit, and entry and exit from each plant room heating and chilled water service.

4.12.2. Test points shall be mounted on the side of pipes and shall be dual purpose for pressure gauge and thermometer, and shall repeatedly reseal.

5. WELDING AND BRAZING:

5.1. Welding and brazing procedures and the competence of operatives shall be in accordance with the recommendations of the following publications, as appropriate:-

- | | | |
|--------|-------------|---|
| 5.1.1. | HVCA TR/3: | Jointing of copper and its alloys - code of practice |
| 5.1.2. | HVCA TR/5: | Welding of carbon steel pipework - code of practice |
| 5.1.3. | BS 1723: | Brazing |
| 5.1.4. | IS EN 1044: | Specification for filler metals for brazing |
| 5.1.5. | BS 2640: | Specification for Class II oxyacetylene welding of carbon steel pipelines for carrying fluids |
| 5.1.6. | BS 2971: | Specification for Class II arc welding of carbon steel pipelines for carrying fluids |

5.2. All welding and brazing shall be executed by competent certified welding and brazing operatives fully experienced in the class of work to be undertaken.

- 5.3. Welding and brazing operatives shall be in possession of a suitable current certificate of competency, appropriate to the jointing method. Copies of certificates shall be submitted to the Engineer prior to work commencing on site.
- 5.4. Welders and brazers shall permanently identify each of their joints with their own marker which will withstand site conditions without damaging system or component performance.
- 5.5. Welds in CHW, fire protection, and unconcealed LTHW systems, shall be visually inspected in accordance with the recommendations of IS EN 970. When visual inspection identifies welding which is unacceptable, the Engineer shall be entitled to have such welding subjected to the non-destructive testing procedures outlined in Part 3.14 of this Specification.
- 5.6. Welds in MTHW, HTHW, steam and gas pipework, and in concealed LTHW pipework, shall be subjected to non-destructive testing in accordance with Part 3.14 of this Specification.
- 5.7. Visual examination, destructive and non-destructive testing of brazing joints shall be carried out in accordance with HVCA code of practice TR/3.
- 5.8. At the Engineer's discretion rectification work on faulty joints shall be carried out by different welders or brazers, and those with failure rates considered excessive shall be taken off the works.
- 5.9. The Contractor shall ensure that all welds are cleaned and protected from rust.

SECTION 3 - STANDARD SPECIFICATION

PART 3.5 - DOMESTIC WATER SERVICES

1. COLD WATER STORAGE TANK(S):

- 1.1. Cold water storage tank(s) shall comply with Byelaw 30, and all relevant Regulations and Local Authority requirements. Tanks shall be of welded or riveted mild steel galvanised after manufacture, pressed steel sectional, glass reinforced plastics or aluminium/galvanised steel lined with a butyl rubber membrane, as appropriate. Tanks over 1000 litres capacity shall be subdivided in accordance with BS 6700 for cleaning and maintenance purposes.
- 1.2. The tank(s) shall be erected strictly in accordance with the manufacturer's instructions and shall be positioned on RSJ supports and secondary steel provided by the Contractor. Three layers of water-proof felt shall be fitted between the tank(s) and all steel supports.
- 1.3. The tank(s) shall be fitted with heavy-duty cover complete with lifting handles. A removable section or hinged manhole shall be provided for access to the ball-float valve(s). The termination of vent pipes into tanks shall permit the easy removal of the covers.
- 1.4. Where the tank depth is greater than 1.5m (or the top of the tank is more than 1.5m from the ground) internal and external ladders shall be fitted, these ladders shall be GRP or stainless steel. The ladders shall have safety cages and conform to BS 4211.
- 1.5. The tank(s) shall be installed in a location that allows for easy access for maintenance of the ball-float valve(s). The ball-float valve(s) shall be suited to the pressure available.
- 1.6. Warning and/or overflow pipes shall be twice the bore of the ball-float valve fitted or 32 mm, whichever is the greater. Unless otherwise indicated, warning and/or overflow pipes shall run to discharge outside the building.
- 1.7. The tank(s) shall be provided with connections for high and low level indicators and temperature sensor.
- 1.8. Multiple cold water storage tanks shall be connected in series complete with by-pass. Each tank shall be capable of being isolated for maintenance purposes.
- 1.9. Any additional requirements shall be as indicated in the Appendices to this Specification.

SECTION NO 3 - STANDARD SPECIFICATION

PART 3.9 - PUMPING EQUIPMENT

1. CIRCULATING PUMPS:

1.1. GENERAL:

- 1.1.1. Values of the resistance to fluid flow indicated are based on the Engineer's design drawings and specified equipment. Any variations from the development of the Contractor's co-ordination and working drawings caused by changes to equipment, components, fittings, pipework layouts, pipework sizes, etc. shall be brought to the attention of the Engineer. The Contractor shall ensure that the pumps provided are capable of delivering the required fluid flow when operating against the actual total system resistance.
- 1.1.2. Pumps shall be entirely suitable for the pumped media, and pressure and temperature requirements.
- 1.1.3. Unless otherwise indicated, pump duties shall be achieved with an impeller shaft speed not exceeding 1450 r.p.m., or by means of infinitely variable speed control drives where specified.
- 1.1.4. Pumps shall be installed in accordance with the manufacturer's recommendations and shall comply with the requirements of IS/EN 60335-2-51, BS 4082 and BS 5257 as applicable, or equivalent. Pumps shall be 'type' tested in accordance with ISEN 9906. Pump curves shall be submitted to indicate performance under all likely operating conditions.
- 1.1.5. Flexible connections shall be provided on the suction and discharge side of all pumps with end connections over 50 mm and elsewhere as indicated.
- 1.1.6. Each pump shall be installed with isolating valves on the inlet and outlet connections. Unless otherwise indicated, a strainer shall be fitted on the inlet connection. Where duty and standby pumps are installed a suitable spring return type check valve shall be fitted on the discharge of each pump. Where standby pumps are indicated with automatic change-over, the change-over shall be initiated and verified by means of flow sensing devices or within pump control logic integral in the pump set.
- 1.1.7. Pressure gauges shall be installed on the suction and discharge flanges of the pump where practical or on the pipework on each side of the pump and as close as possible to the pump connections, unless otherwise indicated.
- 1.1.8. Centrifugal pumps shall be electrically driven by glandless or TEFC squirrel cage motors to IEC standards. Electric motors shall comply with Part 3.11 of this Specification.

1.2. GLANDLESS PUMPS:

1.2.1. Glandless pumps shall be in-line 3 speed type suitable for mounting on wall brackets and shall be complete with thermal insulation on pump housing.

1.2.2. Materials of construction shall be as follows:-

	<u>LTHW/CHW</u>	<u>HWS</u>
Housing:	Cast iron	Bronze
Impeller:	GFPP	GFPP
Shaft:	Stainless steel	Stainless steel
Bearings:	Metal impregnated carbon	Metal impregnated carbon
Seal:	-	Between pump and motor

1.3. DIRECT-COUPLED CENTRIFUGAL PUMPS:

1.3.1. Direct-coupled centrifugal pumps shall be in-line or end-suction single stage dry-motor mechanical seal type, suitable for wall or floor mounting as indicated. Impeller design shall be such that cavitation effects are minimised.

1.3.2. Fixed speed motors shall be suitable for single or three phase supply as indicated and shall have external overload protection. Thermistors where fitted shall be connected to external supply.

1.3.3. In-line variable speed pumps shall be complete with integrated frequency converter and differential pressure sensor. Motors shall be suitable for three phase supply and shall be complete with integrated full overload protection.

1.3.4. Materials of construction shall be as follows:-

	<u>LTHW/CHW</u>	<u>HWS</u>
Housing:	Cast iron	Bronze
Impeller:	GFPP/Cast iron/Bronze	GFPP/Bronze
Shaft:	Stainless steel	Stainless steel
Bearings:	Grease lubricated seal for life ball type	Grease lubricated ball type
Mechanical Seal:	Silicon-carbide/carbon	Carbon/Ceramic/Viton

1.4. FLEXIBLY-COUPLED CENTRIFUGAL PUMPS:

1.4.1. Flexibly-coupled centrifugal pumps shall be end-suction single-stage type with axial suction inlet and radial discharge, complete with support footing and flanged bearing supports, flexible coupling, coupling guard and motor, all on common heavy-duty base-plate suitable for plinth mounting.

1.4.2. Motors shall be suitable for three phase supply and shall have external overload protection. Thermistors where fitted shall be connected to external supply.

1.4.3. Materials of construction shall be as follows:-

LTHW/CHW

Housing:	Cast iron
Impeller:	Cast iron/Bronze
Shaft:	Stainless steel
Bearings:	Grease lubricated seal for life ball type
Mechanical Seal:	Packed gland or GRD

1.4.4. Packed gland wells shall be piped to a drained open tundish adjacent to the pump base.

2. WATER BOOSTER SET(S):

2.1. The water booster set(s) shall be of proprietary packaged construction and shall include all components necessary to ensure full operation of the booster set(s) and to comply with local water authority requirements. All pipework, check valves, isolating valves, pressure switches, pressure gauges and hydraulic accumulators shall be suitable for use with potable water.

2.2. The entire package(s) shall be mounted on a common base frame with holding down bolt holes and shall be fully painted and tested prior to despatch from works. The unit(s) shall be finally commissioned on site by the manufacturer.

2.3. Pumps shall be vertical or end-suction single- or multi-stage mechanical seal type suitable for the application and shall operate in either duty/standby mode or duty/assist mode or any combination of these as indicated. Motors shall be in accordance with Part 3.11 of this Specification.

2.3.1. Materials of construction shall be as follows:-

	<u>Multi-Stage</u>	<u>Single-Stage</u>
Housing:	Stainless steel 304	Cast iron
Impeller:	Stainless steel 304	Bronze/Noryl
Shaft:	Stainless steel	Stainless steel
Bearings:	Grease lubricated ball type	Grease lubricated ball type
Mechanical Seal:	Ceramic/Carbon	Ceramic/Carbon

- 2.4. Pumps shall be controlled by means of pressure switches mounted on the discharge header and shall activate on demand for water with the resultant rise and fall in system pressure. Run-on timers, automatic alternation of duty pumps and BMS link-up facilities shall be provided as standard. Frequency converters, dry run protection and audible alarms shall be provided where indicated.
- 2.5. The control panel(s) shall be of sheet steel to IP 54 unless otherwise indicated and shall be set-mounted and complete with all necessary starters, overloads, pump select switches, etc.
- 2.6. Unless otherwise indicated, the hydraulic accumulator(s) shall be suitable for a maximum working pressure of 8 bar and shall be complete with butyl rubber diaphragm and sealed-in compressed air cushion. A Schrader valve shall be provided for replenishing the air charge of the accumulator as necessary.
- 2.7. A pressure regulating valve shall be installed downstream of the booster set(s) by the Contractor. Where indicated, the Contractor shall install an associated safety valve complete with discharge indication.

SECTION 3 - STANDARD SPECIFICATION

PART 3.10 - AUTOMATIC CONTROLS

1. SCOPE:

- 1.1. This specification covers the design, supply, delivery, installation, supervision, testing, commissioning, demonstration and all other works necessary to be provided by the Building Automation System (BAS) contractor, the Mechanical Contractor and the Electrical Contractor in the implementation of a fully compatible and integrated working BAS system complying in all respects with the requirements of the Engineer.
- 1.2. The BAS Contractor shall furnish and install a complete Direct Digital Control (DDC) temperature control system to automatically control the operation of the entire heating, ventilation and air conditioning system.
- 1.3. Failure to mention any specific item or device does not relieve the Contractor of the responsibility for installing such a device or item in order to comply with the intent of the drawings or the specification.
- 1.4. Any alterations or deviations from this specification will require the prior written approval of the Engineer.

2. CONTRACTOR'S RESPONSIBILITIES

2.1. BUILDING AUTOMATION SYSTEM CONTRACTOR

- 2.1.1. The Building Automation System (BAS) Contractor will provide the following to the specification of the Engineer:
 - 2.1.1.1. Design of the complete building automatic control system.
 - 2.1.1.2. Supply of all equipment and software licences required for the BAS.
 - 2.1.1.3. Supply of all sensors and actuators required for the BAS.
 - 2.1.1.4. Supply of protection devices required to protect all BAS equipment against transient voltage surges.
 - 2.1.1.5. Wiring including specified conduit and 24V AC Power for all BAS equipment in accordance with all local and national codes and European Directives.
 - 2.1.1.6. Configuration of all BAS equipment and software
 - 2.1.1.7. Installation Commissioning

- 2.1.1.8. Seasonal Commissioning
- 2.1.1.9. Client & Engineer demonstrations
- 2.1.1.10. Client training
- 2.1.1.11. All necessary testing
- 2.1.1.12. Operation & Maintenance Manual documentation and as-installed drawings
- 2.1.1.13. Programme modifications necessary to fine tune sequences during commissioning of all systems at no extra cost
- 2.1.1.14. Lead co-ordination with Mechanical & Electrical Contractors regarding electrical requirements of all items of plant
- 2.1.1.15. Supply, offloading and installation of all necessary MCC's and panels
- 2.1.1.16. Supply, installation and commissioning of all Variable Speed Drives (VSD's). VSD's shall be IP 21 rated for wall mounting in plantrooms adjacent to control panels unless otherwise stated. The VSD shall comply with ECG5/3 and EV6100 and any EU directives relating to harmonic distortion
- 2.1.1.17. Warranty service

2.2. MECHANICAL CONTRACTOR

- 2.2.1. The Mechanical Contractor shall install the following equipment furnished by the BAS Contractor to the specification of the Engineer:
 - 2.2.1.1. All pockets, wells and openings for water monitoring devices, flow switches and alarms
 - 2.2.1.2. Airflow monitoring and control devices, openings for flow switches and alarms
 - 2.2.1.3. Smoke dampers, outdoor air, return air, exhaust air and vent dampers with adjacent access doors
 - 2.2.1.4. Supply all relevant manufacturer details to the BAS Contractor as necessary to complete the BAS installation

2.3. ELECTRICAL CONTRACTOR

- 2.3.1. The Electrical Contractor shall provide the following to the specification of the Engineer:
 - 2.3.1.1. Mains power to be taken to each panel box (single or three phase as specified) and fully tested. A test report shall be provided to the BAS Contractor
 - 2.3.1.2. All mains voltage wiring, concealed or exposed, in accordance with the national electrical codes.
 - 2.3.1.3. Emergency electrical power supplied as specified

3. GENERAL REQUIREMENTS

3.1. Automatic Control Systems shall be as indicated and shall form a complete and satisfactory system. All items of control equipment shall be compatible with any client system requirements. As far as possible, field controllers shall be provided by one manufacturer.

3.2. Unless otherwise indicated, the specialist supplier shall include the following:-

3.2.1. HARDWARE

- 3.2.1.1. Networked or standalone DDC controllers as per the control points schedule
- 3.2.1.2. Networked application specific controllers (ASC's) as per the control points schedule
- 3.2.1.3. Networked or standalone communications controllers with true peer-to-peer capability
- 3.2.1.4. All Ethernet switches, routers, hubs, fire-optic adapters as required
- 3.2.1.5. All communications, sensor and actuator copper/fibre-optic cabling and connectivity
- 3.2.1.6. Personal computer operator workstation with supervisory software
- 3.2.1.7. Portable operators workstation with supervisory software
- 3.2.1.8. Interfaces to third party systems such as chillers, boilers, air handling systems, energy metering systems, other energy management systems, access control systems, fire/life safety systems and other building management related devices.
- 3.2.1.9. Printers
- 3.2.1.10. Equipment to ensure wireless supervisory access to the BAS in the local ranges specified
- 3.2.1.11. Equipment to ensure remote supervisory access to the BAS from specified locations
- 3.2.1.12. Sensors and actuators
- 3.2.1.13. HVAC equipment
- 3.2.1.14. Occupant controls
- 3.2.1.15. Alarm annunciators
- 3.2.1.16. Copy of all system software shall be supplied on CD/disk

3.2.2. COMMISSIONING & SETTING TO WORK

- 3.2.2.1. The BAS Contractor shall provide Engineer approved operation and acceptance testing of the complete system. The Engineer or Engineer's representative shall witness all necessary testing.
- 3.2.2.2. On site monitoring, installation advice and support documentation to the Mechanical and Electrical Contractors.
- 3.2.2.3. Pre-commissioning and testing of all points with the system
- 3.2.2.4. Input/output testing of all field devices
- 3.2.2.5. Operational calibration and functional testing of all field devices and equipment
- 3.2.2.6. Acceptance demonstrations of all field devices and equipment including data logging and monitoring of performance

3.2.3. DOCUMENTATION

- 3.2.3.1. Outline description of the control strategy for each system including but not limited to the following items:
 - Heating System
 - Ventilation System
 - Air Conditioning System
 - Water Services System
- 3.2.3.2. Technical specifications for all field devices and equipment
- 3.2.3.3. Outstation Layout drawings
- 3.2.3.4. Network drawings / sub-net drawings
- 3.2.3.5. Control points schedule / analysis of points used and spare points at each location
- 3.2.3.6. Outstation schedule
- 3.2.3.7. Flow charts showing routes through graphical screens
- 3.2.3.8. Network of MCC's and locations
- 3.2.3.9. Wiring diagrams
- 3.2.3.10. Controllers by quantity at each MCC.
- 3.2.3.11. Recommended spares list
- 3.2.3.12. Signed commissioning check sheets
- 3.2.3.13. Signed and dated completion certificate
- 3.2.3.14. Setting sheet recording the as commissioned setting of all control devices and overload settings.

- 3.2.4. The BAS Contractor shall supervise the setting to work and commissioning of the automatic control systems in accordance with the design parameters and manufacturers instructions. Supervision shall include liaison with other parties to the contract to ensure provision of all necessary control points, the suitability of manufacturer's equipment for the purpose, and the appropriateness of equipment locations and the correct wiring and installation of controls.
- 3.2.5. The fixed installation of items of control equipment shall allow access for adjustment and maintenance purposes and shall not hinder the operational effectiveness. Any items of control equipment installed that do not provide adequate access for adjustment and maintenance, or which may hinder the operational effectiveness may be relocated to the satisfaction of the Engineer.
- 3.2.6. The BAS Contractor shall include for interfacing with other systems (e.g. fire alarm, sprinkler) where indicated.
- 3.2.7. Control systems shall be arranged such that, in the event of power failure or any other abnormal operating condition, inherent fail-safe features prevent loss of software and records, and prevent potentially hazardous conditions arising.
- 3.2.8. Control systems shall be protected from radio frequency interference such as that caused by the operation of any radio transmitter, and against power harmonics and power surges.
- 3.2.9. The BAS Contractor shall submit the control strategy developed from tender stage outline control strategy to the Engineer for approval. This shall include points to be data logged. The BAS Contractor shall be responsible for final positioning of control items on Mechanical Services drawings for approval, taking into consideration effective control, cable runs, access and maintenance.
- 3.2.10. The BAS Contractor shall provide sample drawings for this project of the graphic diagram layouts in colour for comment prior to production, and shall demonstrate such graphics for the approval of the Engineer prior to site delivery.
- 3.2.11. The BAS Contractor shall provide the Employer and the Engineer with details of password security and access to the software system up to the highest user level in order that changes may be made on site as required.
- 3.2.12. The BAS Contractor shall submit technical data sheets on all items of control equipment to the Engineer upon request.
- 3.2.13. The Mechanical Contractor shall ensure that sufficient time is allowed in the Main Contractors programme for the BAS Contractor to develop strategies and control points lists, including adequate time after full completion of mechanical and electrical services installations for commissioning and setting to work of the installation and for demonstration of the system on a point-by-point basis.

4. SYSTEM FEATURES

- 4.1. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, Application Specific Controllers and operator devices.
- 4.2. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- 4.3. DDC Controllers shall be able to access any data from any other DDC Controller or combination of controllers on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence on a central processing device.
- 4.4. The system shall be capable of automatically recovering from power failure and retain its memory for a minimum of 6 months without power.
- 4.5. Any supervisory PC software shall be capable of running on the current version of Microsoft Windows software or pre-agreed alternative.

5. FIELD CONTROLLERS

5.1. PACKAGED PLANT INTERFACES

- 5.1.1. The communications controller will act as an interface between the BAS DDC controllers and packaged plant equipment. For packaged plant equipment supporting the Modbus RTU protocol, the Modbus RTU communications port will be directly connected to the communications controller over both an RS485 and RS232 connection as needed. The communications controller shall have the option of being a Master or Slave Modbus device without using peripheral devices.
- 5.1.2. For packaged plant equipment not supporting Modbus, the appropriate gateway equipment and software shall be supplied by the BAS contractor to convert the packaged plant protocol to the protocol used by the communications controller for Get Point and Change Point commands. The following gateways shall be supported by the BAS contractor as needed
 - 5.1.2.1. M-Bus

The BEMS shall include an interface to M-Bus meters. The interface shall conform to the CEN standard EN1434/3. The Cylon M-Bus Gateway shall support the following types of data; ReadOuts, WriteOuts, Datalogs and Alarms.

The interface to the BEMS shall be over TCP/IP and each Cylon M-Bus Gateway shall support up to 60 meters.

5.1.2.2. BACnet/IP

The configuration of the BEMS shall provide an "open" network architecture conforming to the BACnet/IP protocol standard CEN ISO 16484-5. The UC32 Communications Controller shall include BACnet/IP gateway capability to provide integration at the automation level without the need for additional hardware interfaces. This system will allow the specification of BACnet objects for all UC32 Controllers. Integration shall be based on the use of standard IP technology.

5.1.2.3. KNX

The BEMS shall include an interface gateway to KNX networks. The KNX interface shall be in compliance with the CEN standard EN 13321. The interface to the BEMS shall be over TCP/IP and shall support bi-directional point transfer, data logging and alarm monitoring. Example applications include lighting and blind or window control.

- 5.1.3. The BAS contractor shall determine the availability of the appropriate gateway interface to the packaged plant equipment before installation of the equipment.

6. OCCUPANT CONTROLS

Occupant controls allowing the end user to adjust and/or monitor room parameters such as room temperature and/or fan speed, will be provided as per the specification.

6.1. MOUNTING:

- 6.1.1. All occupant controls shall be pattress box mounting with mounting arrangements and dimensions in compliance with BS 8300. There will be no unearthed metal parts accessible by the user.

6.2. VISUAL:

- 6.2.1. Devices will have a neutral colour and will be only slightly larger than the pattress box size for the local area. Devices to be situated in high circulation areas e.g. hotel rooms, will be approved and signed off by the Architect prior to installation.

6.3. FEATURES:

- 6.3.1. Occupant controls will have a selection from these optional features:

- 6.3.1.1. Passive temperature sensor

- 6.3.1.2. Active temperature sensor
- 6.3.1.3. Active humidity sensor
- 6.3.1.4. Rotary dial for passive temperature adjustment
- 6.3.1.5. Linear or rotary switch for 2 or 3 speed fan adjustment
- 6.3.1.6. LCD readout of room temperature
- 6.3.1.7. LCD readout of room temperature setpoint
- 6.3.1.8. Push-button entry of temperature setpoint
- 6.3.1.9. Push-button entry of fan speed

6.4. WIRELESS:

For sites where it is not possible to install wiring for occupancy controls, e.g., marble walls or listed buildings, then wireless occupancy controls may be installed. Minimum cycle time for reading temperature from these devices must be approved by specification prior to installation. Appropriate interface to the BAS will be provided e.g., Modbus.

7. INTEGRATED SYSTEMS

7.1. Open or proprietary communication interfaces shall be provided for the control of:

- 7.1.1. Packaged air handling units
- 7.1.2. Chilled and condenser water management systems
- 7.1.3. Variable speed drives
- 7.1.4. Terminal unit control networks
- 7.1.5. Electrical sub-meters
- 7.1.6. Lift control systems
- 7.1.7. Fire detection and protection systems
- 7.1.8. Lighting control systems
- 7.1.9. Intruder detection systems
- 7.1.10. Access control systems
- 7.1.11. CCTV Systems
- 7.1.12. The use of such software shall not rely upon personal computer hardware for operation, and shall be clearly defined in the technical submittal.

8. CONTROLS STRATEGY SELECTION

- 8.1. The control strategy shall be developed for the BAS system in such a way as to provide the maximum energy/cost savings to the building operator.
- 8.1.1. Alarm levels and inhibits to be configured as specified by the Engineer.
- 8.1.2. Data logs shall be included in each DDC Controller to data log/display all analog inputs and calculated flows and totals.
- 8.1.3. Archives are to be included in recording totals for every utility monitoring meter and every energy meter on site.
- 8.1.4. Passwords controlling various levels of access to the BAS system shall be implemented by the BAS Contractor as agreed with the Client.
- 8.1.5. DDC Controllers at the Motor Control Centre (MCC) shall be programmed to ensure that plant starts in a sequenced manner following a power failure. Time delays to be incorporated into the control programs to limit the total surge in demand.

9. CONTROLS DEVICES

9.1. GENERAL

- 9.1.1. Controls devices shall bear the manufacturers name, part number and shall be supplied complete with technical data sheet containing the following information:-
- Ambient shortage limits
 - Ambient operating limits
 - Dimensions
 - Weight
 - Standards
 - Characteristic
 - Operating range
 - Power supply
 - Power consumption
 - Electrical rating/switching capacity
 - Accuracy
 - Sensitivity
 - Repeatability
 - Response time
 - Wiring diagram
 - Approvals/certification
 - Mounting/installation instructions
 - EMC emissions and immunity standards

- 9.1.2. Controls devices shall be suitably rated to operate safely and reliably in the environment in which they are to be installed.
- 9.1.3. Samples of all types of room-mounted equipment (e.g. detectors, thermostats, etc) shall be provided for approval by the Architect.
- 9.1.4. Controls devices requiring extra-low voltage, e.g. 24V, shall be provided complete with power supply units/transformers by the BAS Contractor.
- 9.1.5. All 230V AC 50Hz operated controls shall be suitable for normal mains voltage fluctuations.
- 9.1.6. The Mechanical Contractor shall weather all devices as necessary that have been installed outdoor and that are exposed to the elements.
- 9.1.7. The BAS Contractor shall ensure during installation of room sensors that adequate consideration is given to location and environmental influences such as solar, thermal bridging or local internal heat gains.
- 9.1.8. The BAS Contractor shall ensure that sensors on walls are suitably sealed to avoid the influences of cold draughts from wall cavities.

9.2. SENSORS, DETECTORS & SWITCHES:

Control devices shall have the following characteristics:-

9.2.1. Room Thermostats:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of $\pm 10^{\circ}\text{C}$.
An integral accelerator/anticipator.
Double insulation.
Scale ranges shall cover a band of at least 5°C and not more than 15°C on either side of the set point.

9.2.2. Duct Thermostats/Frost Thermostats:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of $\pm 20^{\circ}\text{C}$.
An averaging capillary of suitable length to ensure accurate operation shall be serpentine across the duct and shall operate when any 300mm length of sensing element falls below set point. This capillary to be tied firmly in position with the use of suitable retaining clips.

9.2.3. Immersion Thermostats:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of $\pm 20^{\circ}\text{C}$.
A $\frac{1}{2}$ " BSP pocket of minimum length 100 mm.

Concealed setting adjustment.
Scale ranges shall cover a band of at least 5°C and not more than 30°C on either side of the set point.

9.2.4. Safety Thermostats:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of $\pm 20^\circ\text{C}$.
Concealed setting adjustment.
Manual reset type.

9.2.5. Pressure Switches (Pipework):

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
Set point within 30%-70% of scale range.
Differentials adjustable over 10%-30% of scale range.
Connections suitable for 1/4" O.D. copper tube.

9.2.6. Pressure Switches (Ductwork):

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact > 1 amp AC1 rating.
Setting within 30%-70% of scale range.
6 mm nylon pressure connections.
2 mm nylon tubing and duct adaptors
Shall have a switching differential of not more than 10% of the scale range.

9.2.7. Flow Switches:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
Concealed sensitivity adjustment.
Paddles which can be cut to suit pipe diameter.
1" BSP connection.

9.2.8. Current Switches:

Voltage rating shall be suitable for voltages up to 600V A/C.
Normally open contact rating 0.2 amp @ 240V AC
"Switch operated" LED
Suitable for panel mounting and fixing to base plate of panel.
Shall be loop powered without the requirement of external power supply.

9.2.9. Humidistats:

Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of $\pm 3\%$.
Concealed adjustment.
Not require regular maintenance, recalibration or regeneration.

Scale range shall cover a band of at least 10%RH either side of the set point.

9.2.10. Humidity Sensors:

Operable on a 24V AC/DC power supply.
Either a 0-10V DC or 4-20 mA output.
An accuracy of $\pm 2\%$ over working range.
Capacitance type sensing element.
Not require regular maintenance, recalibration or regeneration.

9.2.11. Temperature Sensors:

NTC type thermistor or active transmitters.
NTC type thermistor with minimum resolution of 25 Ohms/0C over working range.
An accuracy of $\pm 0.30C$ over working range.
Not require regular maintenance, recalibration or regeneration.

9.2.12. Pressure Sensors:

Operable on a 24V AC/DC power supply.
Either a 0-10V DC or 4-20 mA output.
An accuracy of $\pm 3\%$ over working range.
Not require regular maintenance, recalibration or regeneration.
Set point shall fall within 40%-70% of the sensing range of the sensor & shall be capable of withstanding hydraulic test pressure of 1.5 times the working pressure.

9.2.13. Damper Actuators:

Shall have sufficient torque to open and close dampers against the maximum out of balance pressure across them.
Spindle passing through actuator and secured by a U clamp.
Each damper actuator to drive not more than 4.0m² of damper area.
Modulating actuators to operate on a 24V AC/DC power supply.
On/off damper actuator - shall be mains operated with limit switches.

9.2.14. Level Switches:

Voltage rating of 230V A/C 50Hz.
SPDT changeover contact with 10 amp ACI rating.
Shall be selected for the fluid type, system pressure and have adjustable differentials.
They may be conventional float type, capacitator type or conductwiring type.
Shall include all probes (including earth) for conductivity type.

9.3. CONTROL VALVES:

9.3.1. STATIC CONTROL VALVES:

- 9.3.1.1. All valves shall be equipped with throttling plugs and removable composition discs. The BAS Contractor shall be responsible for sizing and selecting valves based on information supplied by the Mechanical Contractor. Valve selection charts indicating valve duties, authority and size, and pressure drop calculations shall be submitted to the engineer for comment prior to installation.
- 9.3.1.2. Lift and lay (plug and seat) valves shall be used at all heater battery/heat exchange applications. Rotary shoe (slipper) valves are not acceptable.
- 9.3.1.3. Valves up to and including 50 mm shall have ends screwed to BS 21 and BS 10226-1 and valves 65 mm and over shall have a cast iron body and flanged end connections.
- 9.3.1.4. Valves shall have a maximum rated pressure of at least 200% of the normal working pressure of the system in which they are to be installed.
- 9.3.1.5. On liquid applications, let-by shall not exceed 0.5% of full duty for plug type valves or 1% for shoe types.
- 9.3.1.6. Valves shall be sized to give an authority in the region of 0.5 for diverting and 0.3 for mixing.
- 9.3.1.7. Valves used on heater battery/heat exchangers shall have an equal percentage or modified parabolic characteristic and their range ability shall not be less than 30:1.
- 9.3.1.8. Valves used on heater battery/heat exchangers shall have a stroke of not less than 20 mm with the exception of terminal unit valves.
- 9.3.1.9. Valves used on heater battery/heat exchangers shall have their actuators directly coupled to the valve spindle and shall drive the valve in both directions. Spring operated or thermal valves are not acceptable with the exception of terminal unit valves.
- 9.3.1.10. Valves used on heater battery/heat exchangers shall have a minimum close-off pressure rating of 1 bar.
- 9.3.1.11. Valves shall be fitted with valve position indicators clearly marked to show the fully open and fully closed positions.
- 9.3.1.12. Modulating control valves (with the exception of terminal unit valves) shall be driven on a 0-10V DC signal or a 4-20mA signal. Reversing actuators are not acceptable.
- 9.3.1.13. Manufactured to VDE 2173 or BS 5793 / BS EN 60534.
- 9.3.1.14. Actual valve KVs values shall not deviate from the quoted KVs valve by more than 10%.
- 9.3.1.15. KV of the valve shall not deviate from the stated characteristic curve by more than 10%.

9.3.2. DYNAMIC SELF BALANCING MODULATING CONTROL VALVES

- 9.3.2.1. The BAS Contractor shall supply dynamic control valves where indicated on the schematic drawings to be installed by the Mechanical Contractor.
- 9.3.2.2. All valves shall be electronic, dynamic, modulating 2-way control devices.
- 9.3.2.3. Dynamic control valves shall accurately control flow, independent of system pressure fluctuation.
- 9.3.2.4. Maximum flow setting shall be adjustable to a minimum of 50 different settings with the range of the valve size.
- 9.3.2.5. Valve actuator housing to be rated to IP 44.
- 9.3.2.6. Actuator shall be operated by a 24V DC motor, and shall accept 2-10V DC, 4-20mA, 3-point floating or pulse width modulation electric signal and shall include a resistor to facilitate any of these signals.
- 9.3.2.7. Actuator shall be capable of providing 4-20mA or 2-10V DC feedback signal to the control system.
- 9.3.2.8. External LED readout of current valve position and maximum valve position setting shall be available.
- 9.3.2.9. Valve housing for valve sizes 15-40mm shall be constructed of forged ASTM (CuZn39Pb2) brass rated at no less than 2500kPa static pressure and 120°C.
- 9.3.2.10. Valve housing for valve sizes 50-150mm shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 4000kPa static pressure and 120°C.
- 9.3.2.11. Valve housing shall be double union construction with a range of pipe connections available for the appropriate pipe size.
- 9.3.2.12. Optional dual pressure/temperature test plugs for verifying accuracy of flow performance shall be available for all valve sizes.
- 9.3.2.13. Flow regulation unit shall consist of stainless steel and hydrogenated acrylonitrile butadiene rubber and shall be capable of controlling flow within +/- 5% of each rated flow.
- 9.3.2.14. Flow regulation unit shall be accessible, for maintenance.
- 9.3.2.15. The Mechanical Contractor shall provide a numeric tag for each pressure independent control valve to allow for random testing of design flow temperature and pressure. Tags shall be of aluminium material and 50mm x 25mm in size indicating number, production date and pressure differential range.

9.3.3. AUTOMATIC BALANCING ANALOGUE TEMPERATURE CONTROL VALVES

- 9.3.3.1. The BAS Contractor shall supply analogue temperature control and automatic balancing valves as indicated on the schematic drawings to be installed by the Mechanical Contractor.

- 9.3.3.2. The valve shall consist of a dynamic, accessible, adjustable flow limiting device.
- 9.3.3.3. The valve housing shall be constructed of forged brass ASTM CuZn39Pb2, rated at no less than 1600kPa static pressure at 100°C.
- 9.3.3.4. Pressure / temperature plugs for verifying accuracy of flow performance shall be available for all valve sizes.
- 9.3.3.5. Flow regulation unit assembly shall be manufactured from polyoxymethylene with a hydrogenated acrylonitrile-butadiene rubber or EPDM diaphragm and stainless steel 18-8 spring.
- 9.3.3.6. Flow regulation unit shall be readily accessible, for change-out or maintenance.
- 9.3.3.7. Flow regulation unit shall be externally adjustable to up to 40 different flow rates and shall be available in 3 different kPaD operating ranges; minimum range shall be capable of being activated by a minimum of 17kPaD; and shall be capable of controlling the flow within +/- 5% of the rated flow or +/- 2% of the maximum flow.
- 9.3.3.8. The control valve actuator shall provide a visual indication of the valve position.
- 9.3.3.9. The control valve actuator shall drive closed upon loss of power.
- 9.3.3.10. The valve shall withstand a shut off pressure of at least 400kPa without allowing internal leaking.
- 9.3.3.11. The seat plug shall be manufactured from EPDM rubber.
- 9.3.3.12. The packing box for sealing the stem shall be removable with the stem in operation, without allowing external leakage.
- 9.3.3.13. The Mechanical Contractor shall provide a numeric tag for each automatic balancing analog temperature control valve to allow for random testing of design flow temperature and pressure. Tags shall be of aluminium material and 50mm x 25mm in size indicating number, production date and pressure differential range.
- 9.3.4. DOMESTIC HOT WATER THERMOSTATIC CONTROL VALVES
 - 9.3.4.1. The BAS Contractor shall supply domestic hot water thermostatic control valves as indicated on the schematic drawings to be installed by the Mechanical Contractor.
 - 9.3.4.2. The valve shall consist of a valve housing and a thermostatic accessible cartridge with adjustable element out of contact with the circulating water.
 - 9.3.4.3. Valve housing shall consist of DZR brass CW602N CuZn36Pb2AS or forged brass ASTM CuZn39Pb2, rated at no less than 2500kPa at 100°C.
 - 9.3.4.4. Pressure/temperature test plugs for verifying accuracy of temperature performance shall be available for all valve sizes.

- 9.3.4.5. Valve ball shall consist of chemically nickel plated brass (ASTM CuZn39Pb2).
- 9.3.4.6. Temperature regulation unit shall be manufactured from forged brass ASTM CuZn39Pb2 body, rated at not less than 1000kPa at 100°C. The assembly shall be manufactured of Polyphenylene Sulfide cartridge with stainless steel 18-8 spring and wax element.
- 9.3.4.7. Temperature regulation unit shall be readily accessible for change-out or maintenance.
- 9.3.4.8. Temperature regulation unit shall be step less adjustable to a temperature between 35°C and 65°C and shall be capable of controlling the temperature within +/- 2°C of the rated temperature.
- 9.3.4.9. Temperature regulation unit shall be able to perform either manual bypass or actuated bypass.
- 9.3.4.10. The Mechanical Contractor shall provide a numeric tag for each thermostatic control valve to allow for random testing of design flow temperature and pressure. Tags shall be of aluminium material and 50mm x 25mm in size indicating number, production date and temperature control range.

10. MOTOR CONTROL AND STARTER PANELS:

10.1. GENERAL

- 10.1.1. Mechanical services panels with main isolator up to 250A shall comply with the following clauses of the specification. For larger panels, the BAS Contractor shall refer to the Varming Electrical Services Specification (Low Voltage Switchgear).
- 10.1.2. Unless otherwise indicated, mechanical services panels with main isolator up to 250A shall be 'Form 2B' and shall have the following sections, segregated from each other:-
 - 10.1.2.1. Main isolator / main busbar section
 - 10.1.2.2. Protective device / breaker section
 - 10.1.2.3. Starter section
 - 10.1.2.4. Controller / BAS section
 - 10.1.2.5. Controls section
 - 10.1.2.6. Sub-Meters section
- 10.1.3. Motor control and starter panels shall comply with IS EN 60439, IS EN 60947 and relevant I.S. 10101 codes of practice, as appropriate. Panels shall provide the IS EN 60947-1 degree of protection indicated. Unless otherwise indicated, internal compartments shall be IP 40 rated.

- 10.1.4. Access doors or covers to each compartment of a panel shall be so arranged that access cannot be made until an isolating device interlocked with each door or cover is opened and all equipment accessed through that door or cover is isolated. Unless otherwise indicated, this requirement shall not apply to the 'Control Section' which shall be arranged to permit control adjustment while the plant is operational.

Under these conditions where live work is being contemplated (i.e. working on control section with adjacent section live) a risk assessment and judgement must be made for every situation, by the duty holder, the person working on the control panel which includes:-

- 10.1.4.1. The effectiveness of isolation of the assembly
- 10.1.4.2. The task being performed
- 10.1.4.3. The skill level of the personnel carrying out the work
- 10.1.4.4. The level of separation within the assembly
- 10.1.4.5. The suitability of the separation barriers with the assembly for the task being considered
- 10.1.4.6. The effectiveness of using temporary protective measures
- 10.1.4.7. Use of correct tools, instruments and other equipment
- 10.1.4.8. The use of warning signs

Within this section, as a minimum, all accessible cable terminations carrying mains voltage shall be shielded from direct contact. A purpose made device shall be provided for each panel to enable a competent examiner to override the interlock when the door or cover has been opened.

- 10.1.5. Equipment shall not be fixed to any cover which is removable for maintenance access purposes. Items fixed to a door shall be kept to a minimum and in any case shall not include heavy components or sensitive instruments. All wiring shall be neatly arranged and secured.
- 10.1.6. Unless otherwise indicated, the assembly shall include for 25% spare capacity on all sections.
- 10.1.7. Unless otherwise indicated, each item of plant shall be provided with a 'HAND/OFF/AUTO' switch. Each switch shall be clearly labelled to show which item of plant it controls.
- 10.1.8. Control panel wiring schematics and layouts shall be submitted to the Engineer for comment prior to manufacture. Panels shall be manufactured, equipped, wired and tested before delivery to site. The Engineer reserves the right to make any inspections at works prior to delivery to site.
- 10.1.9. The following spares and accessories shall be supplied with each assembly where applicable:-
 - 10.1.9.1. 2 cubicle access keys
 - 10.1.9.2. 2 fuse withdrawal tools where N.H. style cartridge fuses are used

- 10.1.9.3. 3 spare fuses of each rating and type used in the assembly
- 10.1.9.4. 12 spare bolts used for fixing cubicle side and back cladding
- 10.1.9.5. 25 cl. Tin of touch-up paint
- 10.1.9.6. 6 label fixing screws
- 10.1.9.7. 2 lenses of each colour and type for indicator lamps
- 10.1.10. All door mounted equipment shall be individually labelled with engraved traffolite labels fixed with rivets / screws to the panel fascia.

10.2. MATERIALS AND CONSTRUCTION:

- 10.2.1. The panel enclosure shall be rigidly constructed from suitably prepared and finished best quality folded mild steel of a minimum thickness 2mm or of mild steel angle frame supporting sheets of a minimum thickness 1.2mm, or be a proprietary system of construction to the approval of the Engineer.
- 10.2.2. All panels shall be provided with hinged and lockable access doors or covers at the front of the panel and/or at the back of the panel as required to facilitate maintenance. Locks shall be cylinder type, provided with two keys each, and shall be identical for all panels.
- 10.2.3. Doors shall be flush-fitting mild steel with folded edges and welded corners of a minimum thickness of 2mm with concealed non-ferrous hinges, or of alternative construction to the approval of the Engineer. Framework associated with doors shall be fitted with skinned foam plastic dust protective strip or neoprene tube sealing gaskets.
- 10.2.4. Finished panels shall be without rough or sharp edges and shall present smooth surfaces. All exposed screws, bolts and similar fastenings shall be protectively plated.
- 10.2.5. Panels shall be finished externally with a full or semi-gloss stove-enamelled finish to BS colour of RAL 7032. All internal and external surfaces shall be properly prepared before final finishing.
- 10.2.6. Panels secured to a finished floor shall be provided with a metal plinth. A metal plinth is not required with panels mounted on a raised builders work base. All panels shall be provided with fixing holes. Large panels or panels exceeding 75kg shall be provided with detachable lifting eyes.
- 10.2.7. Heat generating devices such as starters, transformers, relays, etc. shall be mounted on a DIN rail with adequate spacing between each unit to allow for heat dissipation. End stops shall be provided on DIN rail mounted equipment as necessary to prevent movement.
- 10.2.8. Panel wiring for electronic thermostatic and humidity control sensors, and for any other items as necessary, shall be in screened multicore flexible cable. Extra low voltage wiring and connections shall be segregated from those for higher voltage or be insulated for the highest voltage present. Starter auxiliary contacts shall be volt-free.

- 10.2.9. Fuses shall comply with the requirements of BS 88 and shall be grouped and mounted so as to be readily and safely accessible.
- 10.2.10. Grouped terminal blocks of adequate size and capacity shall be provided for all cables leading to equipment outside the panel. A removable cover, or other facility such as a removable blank flat gland plate, shall be provided for the entry of incoming cables, conduits, trunking, etc. with means for effective electrical bonding to the panel.
- 10.2.11. The control circuitry within panels shall be arranged such that each control system is separately protected. For the purpose of this clause, a 'control system' shall be defined as that necessary to sustain an item of plant and/or control a zone. Stand-by plant shall have separately fused supplies.
- 10.2.12. Provision shall be made for the earthing of all non-current carrying panel and equipment metalwork including panel doors. All necessary electrical bonding shall be provided together with an earthing terminal of adequate size, positioned within the panel at the rear or bottom on a part which is not removable. Access shall be provided for making connections to the earthing system.
- 10.2.13. All control circuits wiring shall be numbered to assist fault finding and manufacturer. These numbers to be recorded on the "As Constructed" panel drawing.

10.3. IDENTIFICATION LABELS:

- 10.3.1. Fuses, terminal blocks and all other items of equipment within panels shall be suitably identified by means of clearly inscribed labels of a permanent nature attached or adjacent to them. All items on the outer surfaces of panels shall be identified with laminated plastic labels engraved white/black/white and shall be fixed with screws or rivets. The full requirements of IS EN 60439-1 shall be provided.

10.4. VENTILATION:

- 10.4.1. The temperature rise in panels shall not exceed the limits stated in IS EN 60439-1. Where automatic control items are installed, panel construction shall provide adequate ventilation for internal heat dissipation. Provisions shall be made to ensure that the internal temperature is limited to 10°C above ambient.

10.5. INSTRUMENTS AND INDICATION:

- 10.5.1. All indicating lamps, instruments and controls shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and facilitate maintenance. Externally visible equipment shall be flush-mounted and fixed securely to the faces of control panels. Internal equipment shall be fixed to purpose-made rails or mounting bars. All fixings shall incorporate shake-proof washers or other vibration resistant fastenings.
- 10.5.2. The colours and colour significance of indicator lamps shall be in accordance with IS EN 60073, unless otherwise indicated. Where extra low voltage filament lamps are installed, they shall be fed from a double-wound transformer complying with BS 3535. Permanent legible information shall be provided adjacent to each indicator lamp to readily identify its function.
- 10.5.3. Where indicated, facilities shall be provided within the panel for remote alarm and fault indication. A lamp test facility shall be provided on all panels having four or more indicator lamps.
- 10.5.4. Indicator lamps and instrumentation shall function with selector switches in the 'HAND' or 'AUTO' position.

10.6. STARTERS AND CONTROL GEAR:

- 10.6.1. Unless otherwise indicated, starters shall comply with IS EN 60947-4-1. The 'rated duty' shall be 'intermittent' and the class of intermittent duty of the starter shall be appropriate to its operating conditions.
- 10.6.2. The following types of starters will be accepted unless otherwise indicated:-
 - 10.6.2.1. Motors up to between 0.75kW and 5.5kW output, 230V, single-phase: direct-on-line starter.
 - 10.6.2.2. Single-speed motors over 5.5kW output, 400V, three-phase: star-delta or soft-start.
 - 10.6.2.3. Single-speed motors over 5.5kW output, 400V, three-phase: star-delta open or closed transition, auto-transformer closed transition, rotor resistance, part-winding or soft-start. For multi-circuit winding motors (part winding), the starter shall start the motor on one set of windings and provide a reduced starting current not exceeding 65% of full voltage locked-rotor current.
 - 10.6.2.4. Multi-speed motors with independent windings shall start on the low speed winding.
 - 10.6.2.5. Control circuiting to provide for all ASD and multi-speed to start on low after loss of power supply.
- 10.6.3. For starters incorporating reduced voltage starting, the changeover of voltage shall be automatic. All reduced voltage starters shall have an adjustable transition line.

- 10.6.4. Starters shall be provided with a manually reset device for ambient temperature compensated thermal overload protection on each phase and single-phase protection. Multi-speed motors shall be protected by a thermal overload device in each circuit. Provision shall be made for limiting the number of motor starts per hour, having due regard for operating requirements.
- 10.6.5. Every electric motor shall be provided with separate control gear, starting equipment, protective device, manual isolator and shall be connected to a separate final circuit.
- 10.6.6. Each panel shipped to site shall contain a copy of its factory test certificate. A second copy of this certificate to be included in the O&M manuals.
- 10.6.7. Each panel shipped to site shall contain a laminated terminal number listing which should be permanently affixed to the inside of the terminal section door.
- 10.6.8. Each panel shipped to site shall contain a laminated MCB/fuse list which shall be permanently affixed to the inside of the MCB section door.
- 10.6.9. Unless otherwise stated the panel shall have a minimum fault rating of 6KA and all switchgear and components shall be selected to achieve type 2 co-ordination.

11. FIXING AND CONNECTION

11.1. CONTROL WIRING

11.1.1. GENERAL REQUIREMENTS:

Single source responsibility of supplier shall be the complete installation and proper operation of the BAS and control system and shall include debugging and proper calibration of each component in the entire system. The BAS must be supplied and installed by the same BAS Contractor.

At the operators workstation, sufficient 13A mains sockets shall be provided to prevent the need for distribution adapters. At least one spare 13A socket shall be provided.

All electronic equipment shall be certified and identified with CE symbol under CE regulations for light industrial applications.

The BAS shall comply with UL 916 PAZX.

The BAS Contractor shall nominate a competent Project Manager who is capable of answering field questions, is aware of all schedules and schedule changes, and is responsible for the BAS installation and co-ordination of work with all other contractors. The Project Manager shall be available to attend on site meeting and shall respond to all BAS related queries.

11.1.2. CABLE ROUTING AND SHIELDING:

All low voltage signalling cables shall be shielded twisted pair to the specification of the BAS equipment manufacturer. Cable shields shall be earthed at one point only for each cable run, to avoid electrical noise due to ground loops. Shield earthing point shall be at the outstation end.

The BAS cables shall be separated from mains cables by at least 25mm and should not be run in the same conduit.

Input and outputs must not be mixed in multicore cables and must be run in separate cables. Analogue and digital inputs may be mixed in multicore cables. Analogue and digital outputs must be run in separate cables.

All cables must be protected against incorrect wiring, static transients and induced magnetic interference.

11.2. CABLE SPECIFICATIONS:

11.2.1. SENSORS AND DIGITAL INPUTS:

- 11.2.1.1. 2 core (1 pair) shielded cables with stranded copper wire
- 11.2.1.2. Distances up to 500m: AWG 22 (0.5mm²) e.g. Belden 9414, 9462, 8671, 9461
- 11.2.1.3. Distances up to 1000m: AWG 18 (1.0mm²) e.g. Belden 8760, 9409
- 11.2.1.4. Minimum copper cross-section area: AWG 22 (0.5mm²)
- 11.2.1.5. Maximum copper cross-section area: AWG 14 (2.5mm²)
- 11.2.1.6. Recommended copper cross section area for PT1000 sensors: AWG 18 (1.0mm²)

11.2.2. RELAY OUTPUTS:

- 11.2.2.1. For mains rated relay contacts i.e. 230V @ 5A use stranded 1mm²

11.2.3. ANALOGUE AND DIGITAL OUTPUTS:

- 11.2.3.1. 2 core (1 pair) shielded or unshielded with stranded copper wire
- 11.2.3.2. Distances up to 500m: AWG 22 (0.5mm²) e.g. Belden 9407
- 11.2.3.3. Distances up to 1000m: AWG 18 (1.0mm²) e.g. Belden 8760, 9409, 8461
- 11.2.3.4. Minimum copper cross-section area: AWG 22 (0.5mm²)
- 11.2.3.5. Maximum copper cross-section area: AWG 14 (2.5mm²)
- 11.2.3.6. Recommended copper cross section area: AWG 18 (1.0mm²)

11.2.4. TWISTED PAIR ETHERNET NETWORK

- 11.2.4.1. Category 5e or Cat 6, 8 cores, 4 twisted pairs, unshielded or shielded, solid conductors, AWG 24

- 11.2.4.2. Maximum length 100m including patch cables
- 11.2.4.3. Unshielded cable types Belden 1583A, 7918A, 1700A
- 11.2.4.4. Shielded Ethernet cables must be installed by qualified engineers with Ground Loop avoidance training and shielded RJ45 connectors.
- 11.2.4.5. Shielded cables are only required in the event that the site is found to have high electrical noise.
- 11.2.4.6. Shielded cable type: Belden 7929A
- 11.2.5. FIBRE OPTIC ETHERNET NETWORK
 - 11.2.5.1. 62.5/125 duplex fibre optic cable
- 11.2.6. CO-AXIAL ARCnet NETWORK
 - 11.2.6.1. Co-axial cable with 93R impedance
 - 11.2.6.2. Type RG62A/U
- 11.2.7. TWISTED PAIR ARCnet NETWORK
 - 11.2.7.1. 2 core (1 pair) shielded, twisted pair, low capacitance cables with stranded copper wire
 - 11.2.7.2. Minimum copper cross section area: AWG 24 (0.3mm²) e.g. Belden 9841 – distances less than 600 metres
 - 11.2.7.3. Maximum copper cross section area: AWG 18 (1.0mm²) e.g. Belden 9841 – distances up to 1200 metres
 - 11.2.7.4. Recommended copper cross section area: AWG 22 (0.5mm²) e.g. Belden 3105A
- 11.2.8. FIELDBUS
 - 11.2.8.1. 2 core (1 pair) shielded, twisted pair, low capacitance cables with stranded copper wire
 - 11.2.8.2. Minimum copper cross section area: AWG 24 (0.3mm²) e.g. Belden 9841 – distances less than 600 metres
 - 11.2.8.3. Maximum copper cross section area: AWG 18 (1.0mm²) - distances up to 1200 metres
 - 11.2.8.4. Recommended copper cross section area: AWG 22 (0.5mm²) e.g. Belden 3105A

12. TESTING AND COMMISSIONING:

12.1. GENERAL:

- 12.1.1. The BAS Contractor shall provide all test equipment and hand-held radio transmitters as required for all stages of testing, commissioning and demonstration. Recent calibration certificates must be provided for all test equipment used. The Engineer may be present to witness all testing.

12.2. FINAL WIRING CONNECTIONS:

- 12.2.1. The BAS Contractor shall be responsible for checking all automatic control system wiring and making-off of final connections at outstations, user-interfaces, panels, field controllers and control devices. All cables to be glanded, stripped and each core prepared for inserting in terminal, tested and clearly labelled by the electrical contractor prior to final termination by the BAS Contractor.
- 12.2.2. All screened cables shall be earthed at the control panel only; at the field device the screen shall be cut back and insulated.

12.3. PRE-COMMISSIONING/TESTING:

- 12.3.1. The BAS Contractor shall be responsible for pre-commissioning and testing. At pre-commissioning stage, the BAS Contractor shall examine all automatic control systems wiring and connections on the system in order to ensure that no damage will occur to any equipment whether provided by the BAS Contractor or not.
- 12.3.2. The exact method of testing shall be the responsibility of the BAS Contractor.
- 12.3.3. The BAS Contractor shall supply signed test sheets for all equipment connected to the system. These sheets shall clearly indicate and sign-off on each of the following headings:-
 - 12.3.3.1. Equipment Selection
 - 12.3.3.2. Installation
 - 12.3.3.3. Termination
 - 12.3.3.4. Function
 - 12.3.3.5. Calibration
 - 12.3.3.6. Correct Operation

12.4. INPUT/OUTPUT TESTING:

- 12.4.1. The BAS Contractor shall arrange the operation or simulated operation of all plant, equipment and controls devices and verify the controls signal at the user interface. This procedure shall be witnessed by the Engineer. The BAS Contractor shall supply signed sheets for these tests.

12.5. OPERATIONAL TESTING:

- 12.5.1. After completion of pre-commissioning/testing and input/output testing, each sub-system shall be fully tested to ensure correct operation as per the approved control strategy.
- 12.5.2. The BAS Contractor shall revisit the site after handover and allow for 1 week to check and adjust the parameters for BAS control to optimise settings.

12.6. ACCEPTANCE DEMONSTRATIONS:

The BAS Contractor shall demonstrate the following in the presence of the Client and the Engineer:-

12.6.1. FIELD EQUIPMENT DEMONSTRATION

- 12.6.1.1. Automatic control operation shall be verified by introducing and error into the system and observing the proper corrective system response.
- 12.6.1.2. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- 12.6.1.3. An output channel will be commanded (on/off, stop/start, adjust, etc.) and operation verified.
- 12.6.1.4. An analog input channel will be verified by changing the state of the field device and observing the appropriate change of displayed value.
- 12.6.1.5. A digital input channel will be verified by changing the state of the field device and observing the appropriate change of displayed value.
- 12.6.1.6. Typical occupancy control device function shall be demonstrated.
- 12.6.1.7. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.

12.6.2. WORKSTATION DEMONSTRATION

- 12.6.2.1. Communication with typical main plant and ASC controllers shall be demonstrated
- 12.6.2.2. Operator commands shall be explained and demonstrated

- 12.6.2.3. Selected control sequences shall be demonstrated for proper operation
- 12.6.2.4. Review of time schedules and alarm priorities
- 12.6.2.5. Selected system reports and logs shall be demonstrated at the system workstation
- 12.6.2.6. Correct system start-up and shutdown procedures shall be demonstrated
- 12.6.2.7. Selected controllers shall be demonstrated to operate in standalone mode

12.7. SYSTEM HANDOVER

12.7.1. The BAS Contractor shall ensure the following are completed at handover stage:-

- Any issues requiring corrective actions to be documented and agreed date determined for clearance
- All access levels and passwords recorded and backed up
- Consumables, printer ribbons, printer paper as agreed with the Client
- All keys necessary for access to panels and equipment to be presented to the Client.
- Recommended spare parts list and contact details for all suppliers
- Operating and maintenance cautions and instructions
- Unless otherwise indicated, the BAS Contractor shall allow 2 days formal training for 3 people, over a time span of two weeks, and shall provide all necessary items (e.g. hardware, software, consumables, etc.) to accomplish this.

12.7.2. OPERATOR TRAINING

The BAS Contractor shall provide detailed on-site and off-site training to selected client staff. Training shall be carried out separately for both engineering and operator staff. Factory trained control engineers and technicians shall provide training sessions for the clients personnel.

Training shall include:-

- 12.7.2.1. Explanation of drawings, operations and maintenance manuals
- 12.7.2.2. Overview of HVAC system
- 12.7.2.3. Walk-through of project to locate control components
- 12.7.2.4. Operator workstation and peripherals
- 12.7.2.5. Operation of portable operators workstation including any wireless equipment
- 12.7.2.6. Use of occupancy controls

- 12.7.2.7. Use of keypad/display devices with customised menus
- 12.7.2.8. Use of overrides and passwords
- 12.7.2.9. Use of data logs, time schedules and alarms handling
- 12.7.2.10. Communication Controllers, DDC Controllers, ASC operation/function
- 12.7.2.11. Operator control functions including graphic generation and field panel programming
- 12.7.2.12. Explanation of adjustment, tuning, calibration and replacement procedures.

The Client may require their personnel to have more comprehensive training of the hardware and software and this must be available from the BAS Contractor. If such training is required, it shall be contracted at a later date. The BAS Contractor shall provide a description of available local and factory based Client training.

13. RECORD DOCUMENTATION:

- 13.1. The preparation, completion and issue of record documentation by the BAS contractor shall comply with Part 3.15 of this Specification.
- 13.2. Controls systems record documentation shall include, but is not limited to, the following:-
 - 13.2.1. Two copies of all system and database files supplied on CD with appropriate identification
 - 13.2.2. An Operator Reference Table, listing the addresses of all connected points. Settings shall be shown where applicable
 - 13.2.3. BAS system drawings matching the installed networks, equipment and peripheral connections
 - 13.2.4. Flow charts of the control software programs utilised in the temperature control system
 - 13.2.5. Controls programs used in each DDC Controller
 - 13.2.6. Recommended spare parts list and contact details for all suppliers
 - 13.2.7. Operating and maintenance cautions and instructions
 - 13.2.8. Commissioning test sheets
 - 13.2.9. Control points list
 - 13.2.10. As-commissioned MCC drawings

- 13.2.11. Equipment data sheets
- 13.2.12. System operational description
- 13.2.13. Setting sheets
- 13.2.14. Maintenance proposal
- 13.2.15. Completion certificate
- 13.2.16. Test equipment calibration certificate
- 13.2.17. Control panel factory test certificate

SECTION 3 - STANDARD SPECIFICATION

PART 3.11 - MISCELLANEOUS ITEMS

1. INSTRUMENTS:

1.1. GENERAL:

- 1.1.1. All instruments, gauges and devices which have indicating scales shall be so mounted to be accessible and easily read from floor level or from platforms without the need for additional means of access. Where instruments cannot be mounted in an easily read position, remote reading types shall be provided.
- 1.1.2. Scale ranges shall be appropriate the plant when running and when at rest. The design maximum operating condition shall be indicated at approximately 75% of full scale. Unless otherwise indicated, gauges and dial thermometers shall be to the accuracy required by IS EN 837-1 and BS 5235 respectively.
- 1.1.3. Thermometers shall be graduated in degrees Celsius. Hydraulic gauges shall be calibrated in bar and/or kPa to suit the application. Instruments indicating duct air pressure shall be graduated in Pascals.
- 1.1.4. Instruments shall not be subject to vibration in their installed position.

1.2. PRESSURE GAUGES:

- 1.2.1. Pressure gauges shall be installed generally as indicated on the drawings and on system pressurisation equipment, main headers, closed expansion vessels, boilers, calorifiers, each side of pressure reducing valve sets, the suction and discharge of each pump and on inlet and outlet of evaporators, condensers and cooling towers.
- 1.2.2. Pressure gauges shall have dials calibrated in bar from zero to not less than 1.3 times and not more than twice the operating pressure. Where fitted on pressure vessels and boilers, the gauges shall be as required by BS 759 with dials not less than 150 mm dia. and with cases of enamelled steel. Where fitted elsewhere, the dials of gauges shall be not less than 100 mm dia. and the cases shall be of enamelled steel or moulded plastics.
- 1.2.3. In addition to the indicating black pointer, gauges shall be provided with an adjustable tamper-proof red pointer set to indicate the normal working pressure of the system and a distinctive purple line at the maximum permissible pressure.

2. BASES, FOUNDATION BOLTS AND ALIGNMENT:

- 2.1. The Contractor shall be responsible for providing all dimensions and details for brick or concrete equipment bases to the Main Contractor, and for ensuring that the bases are constructed to the necessary requirements.
- 2.2. The Contractor shall be responsible for aligning and levelling up each item of equipment supplied under the contract, using steel shims as necessary, for placing the holding down bolts in the correct position and for supervising the grouting in of the bolts and the shims.

3. LUBRICATING OILS:

- 3.1. The Contractor shall include for providing all oils and greases for lubrication, valve or gland packings, and shall include for all necessary following up and topping up of these items to ensure that the correct levels and conditions are obtained at the time of hand-over.

4. NOISE:

- 4.1. Care shall be taken in the selection and installation of plant and equipment to ensure that the noise level in the spaces served, in any adjacent buildings and within plant rooms does not exceed the indicated maximum acceptable noise rating (NR). In the spaces served the noise level due to the plant and equipment shall comply with the recommended criteria given in the CIBSE Guide, Book A1, Table A1.10, unless otherwise indicated.

5. VIBRATION ISOLATION:

- 5.1. All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be purpose designed and selected to suit the machinery. Where mat type isolation materials are used the Contractor shall supply the materials and be responsible for their correct location; all other vibration isolators shall be supplied and installed by the Contractor.
- 5.2. For fans and air distribution systems flexible joints shall be provided to minimise the transmission of vibration. For pumps and water distribution systems, purpose-designed flexible connections shall be provided to minimise the transmission of vibration. The connections shall be compatible with the tube materials and methods of jointing and the fluid handled in the system.

6. BELT DRIVES, VARIABLE SPEED DRIVES AND GUARDS:

6.1. BELT DRIVES:

- 6.1.1. Belt drives shall comply with BS 3790 and be capable of transmitting at least the rated power output of the driving motor at any stage of operation with one belt removed. Unless otherwise indicated, not less than two belts per drive shall be used. Belts shall be of rubber and fibre 'vee' section unless otherwise indicated. Pulleys shall be correctly aligned and in accordance with the manufacturer's requirements.

6.2. VARIABLE SPEED DRIVES:

- 6.2.1. Unless otherwise indicated, variable speed drives shall be pulse width modulation or direct torque control type complete with line supply filters and inverter unit mounted in suitable enclosures to IS EN 60439, by-pass unit and all necessary controls. Enclosure temperatures shall be limited to 40°C, with forced ventilation where necessary. Enclosure construction shall provide protection of appropriate IP rating to IS EN 60529.
- 6.2.2. Unless otherwise indicated, variable speed drives shall have the following features:
 - 6.2.2.1. Mains on lamp.
 - 6.2.2.2. Manual/auto selector switch - manual control via potentiometer, auto control via remote 4-20MA input signal.
 - 6.2.2.3. The variable speed drives shall comply with the requirements of Engineering Notice G5/3 and have a Total Harmonic Distortion of not more than 10%.
 - 6.2.2.4. The variable speed drives shall be matched to the motors to which they are applied which shall be suitably de-rated for the effects of the harmonics generated.
 - 6.2.2.5. Fire shutdown interface to be adjustable for 'normally closed' and 'normally open' operation.
 - 6.2.2.6. Variable speed drives shall be filtered as necessary to prevent electro-magnetic interference to other Extra Low Voltage equipment.
 - 6.2.2.7. Variable speed drives shall be used to control fan/pump speed in order to meet varying air/water volume flow requirements. Integral controls shall ensure that the fan/pump speed cannot be accelerated or decelerated at a rate that will cause spurious or nuisance tripping due to over-current, back EMF or for any other reason. This requirement applies to both manual and automatic control.

6.3. GUARDS:

- 6.3.1. Guards shall comply with BS 5304 and be provided to all open fan intakes and exhausts, all forms of open power transmission systems including belt drives, drive shafts and drive couplings, discharge openings from cooling towers, and where indicated.
- 6.3.2. Fixed guards shall be installed to prevent inadvertent contact with dangerous parts of machinery. Construction and installation shall ensure strength and rigidity. It shall not be possible to remove any guard without the aid of a tool.

7. ELECTRICAL ITEMS:

7.1. GENERAL:

- 7.1.1. Unless otherwise indicated, all electrical power wiring will be the responsibility of the electrical contractor.
- 7.1.2. The Contractor shall be responsible for the prompt issue of all information concerning motor kW ratings, starting and operating currents, number of phases and wiring diagrams to the electrical contractor. This information shall be provided in such time as to allow the electrical contractor to progress his work so as to avoid delays.
- 7.1.3. The Contractor shall be responsible for the accuracy of all information supplied to the electrical contractor and for the correct internal wiring of all pre-wired equipment supplied for the contract. The Contractor shall reimburse the full cost of abortive or remedial work due to any error in these respects.
- 7.1.4. Unless otherwise indicated, the Contractor shall supply starters associated with items of equipment not under automatic control to the electrical contractor for installation. Isolators and protective devices of types appropriate and necessary for the works shall be provided by the electrical contractor.
- 7.1.5. All control panels supplied by the Contractor with packaged mechanical services equipment shall comply with Part 3.10 of this Specification.
- 7.1.6. The Contractor shall mark out on site, in conjunction with the electrical contractor, the position of all his electrical controls and equipment.
- 7.1.7. Safe Electric or appropriate governing body Subsystem Completion Certification shall be in accordance with the Appendix to this Specification.

7.2. ELECTRIC MOTORS:

- 7.2.1. Each motor shall comply with the appropriate parts of BS 4999, BS 5000 and IS EN 60034 and shall be of such a size and type to start and drive the equipment under normal conditions of service without overloading

- 7.2.2. Motors shall be continuously rated and shall have insulation in accordance with BSEN 60085 Class F as a minimum unless otherwise indicated. Classes Y and A shall not be used.
- 7.2.3. Motor enclosures shall comply with IS EN 60529 and the degree of protection shall be appropriate to the location and environment in which the motors are to operate.
- 7.2.4. Motors arranged for automatic starting shall have a label of durable material fixed permanently to them in a prominent position, giving a clearly inscribed warning that the motor is automatically controlled and must be isolated before inspection.

7.3. BONDING:

- 7.3.1. The Contractor shall ensure that all the metallic installations he provides which constitute 'Extraneous conductive paths' shall be electrically bonded by the electrical contractor prior to insulation.

8. WATER TREATMENT:

- 8.1. Pre-treatment plant and chemical conditioning equipment shall be provided as indicated. The equipment shall comprise purpose-made sets by specialist manufacturers and shall include all necessary components and sundries.
- 8.2. Water treatment plant and equipment shall be arranged in neat and compact layouts allowing proper access for maintenance and for simple operation without spillages.
- 8.3. Proposals for water treatment installations, detail design and equipment selection shall be submitted to the Engineer for approval prior to order.
- 8.4. Water treatment systems shall be supplied, installed and fully commissioned for operation at plant start-up.
- 8.5. Chemicals used for water conditioning and the methods of storage and effluent discharge shall comply with the relevant local bye-laws and regulations.

SECTION 3 - STANDARD SPECIFICATION

PART 3.12 - THERMAL INSULATION

1. GENERAL:

- 1.1. The following specification covers the requirements for the insulation of hot and cold surfaces subject to heat loss, heat gain or condensation, and for personnel protection and noise insulation.
- 1.2. Thermal insulation and methods of application shall comply with BS 5422 (2009) and BS 5970 (2012). Thermal insulation of buried services shall comply with BS 4508-1 (1996) and amendment 7727 (1993). Thermal insulating materials shall comply with BS 3927, BSEN 13166 (2012) and amendment A2 (2016), BS 3958 (1972, 1986) and BS 5608 (1993) as appropriate. All thermal insulation materials and methods shall comply in full with the current Irish Building Regulations and with all the accompanying current Technical Guidance Documents.
- 1.3. Unless otherwise indicated (or as excepted by clause 1.4), thermal insulating materials shall, when tested in accordance with the current BS 476-1 to 20 (2014), be classified non-combustible. Insulation-facing materials shall be inherently non-combustible. Materials shall be free from substances which, in the event of fire, would generate appreciable quantities of smoke or noxious or toxic fumes.
- 1.4. Within the building structure, insulating materials and their finishes whose surface classification complies with Class 0, as defined by the Building Regulations, may be used.
- 1.5. The following materials shall not be used:-
 - 1.5.1. Materials containing mineral fibres which are not contained or stabilised by materials to prevent migration.
 - 1.5.2. Insulation using CFCs in its manufacture.
 - 1.5.3. Materials having asbestos content.
 - 1.5.4. Polystyrene material.
- 1.6. Glass or rock fibre insulation shall not be used in kitchens, food preparation or food storage areas (including ceiling voids and ducts, and access from these areas, etc.), nor in air-conditioned aseptic areas.

- 1.7. Materials, adhesives, sealants and finishes shall be suitable in all respects for continuous use without degradation throughout the range of operating temperatures and within the environment indicated. They shall be designed to provide proof against rotting, mould, fungal growth and attack by vermin and degradation through UV radiation when used externally. All materials shall be non-hygroscopic.
- 1.8. All insulating materials and associated products shall be applied in accordance with manufacturers recommendations and instructions. Work failing to comply with these will not be accepted by the Engineer.
- 1.9. All materials delivered to the site shall be new and dry, and so maintained throughout the progress of the works.
- 1.10. The Contractor shall furnish all necessary stores, materials, labour, equipment, tools and supervision required and shall transport all material, tools and equipment to and from the job site, including loading and unloading.
- 1.11. No portion of equipment or piping shall be insulated until all hydrostatic testing has been completed and the item released for insulation by the Engineer.
- 1.12. Unless otherwise indicated, any cutting and/or repairs to buildings or structural members which may be required will be carried out by the Main Contractor, where a Main Contractor is in place, otherwise such work shall be carried out by the appointed Mechanical Contractor.
- 1.13. The Contractor shall remove all foreign matter from the surface to be insulated.
- 1.14. The Contractor shall furnish, erect and remove all scaffolding required for insulation erection and shall spread tarpaulin and otherwise safeguard buildings and equipment as required, to protect same from dirt and debris incidental to the insulation contract. All debris shall be removed each day and the site shall be left in a clean condition.
- 1.15. In no circumstances shall untidy or badly constructed insulation be installed. The Contractor shall be required to remove such insulation and replace with the insulation to the standard required by the Engineer. The Contractor shall be required to carry out this work at his own expense.
- 1.16. All insulation must be dry and applied over dry surfaces. Where the Contractor must leave an item unfinished, e.g. overnight, he shall provide temporary weatherproofing.
- 1.17. To avoid corrosion aluminium must not come into direct contact with metals of a different electrical potential. If necessary, an intermediate layer of plastic material shall be inserted between the contact surfaces. The material for self-tapping screws, common to both metals, shall be carefully selected.
- 1.18. Straps used to secure insulation shall be stretched to the proper tightness before clamping. Protruding ends shall be trimmed and turned in against the insulation.

- 1.19. Preformed insulation surfaces shall be smooth, unbroken, uniform and firm. Outer coverings shall be continuous through support joints. At all points of support, insulation, cladding and vapour barrier shall not be pierced or fouled by the supports. At points of support means of load distribution shall be provided as necessary. Refer to BS 5970 : 2012, Figure 12, Figure 14, Figure 15 for fluids operating below ambient temperature and Figure 13 for fluids operating above ambient temperature.
- 1.20. Clearances shall be sufficient between each pipe/service to allow for the thickness of insulation as indicated in this Specification. Additional space/clearance may be required where insulated pipe sleeves are used, e.g. steam, cold and chilled water services and heated/cooled etc. ductwork. All statutory and best practice clearances shall be allowed for between mechanical and electrical services.
- 1.21. Where insulating materials are finished with metallic cladding, the cladding shall be bonded by the electrical contractor in accordance with I.S. 10101.
- 1.22. All pipework and ductwork hydraulic and air tests shall be satisfactory completed and witnessed and all surfaces shall be prepared to the Engineer's satisfaction, prior to any insulation being applied.
- 1.23. A complete vapour seal shall be provided on cold surfaces by vapour barrier jackets or coating. All vapour barriers shall be continuous and where this is not possible, the vapour barrier must be sealed to the pipework / ductwork to prevent the ingress of water or moisture.
- 1.24. GENERAL STATEMENT ON INSULATION WORKMANSHIP
 - 1.24.1. Generally all insulation work shall be carried out by experienced established professional insulation contractors.
 - 1.24.2. All work shall comply with BS 5970 (2012) and specifically with Section 4 of that standard.
 - 1.24.3. Generally all insulation shall be accurately fitted and cut, accurately mitred, free from any damage or tears, fully bonded or otherwise secured and correctly terminated at flanges, pumps, heat exchanger, vessels or other plant items.
 - 1.24.4. All unfitted insulation materials shall be stored on site in dry secure stores and all necessary measures shall be taken to ensure that no damage occurs to the insulation while unfitted in storage or fitted in situ prior to handover of the building.
 - 1.24.5. The Contractor is responsible for ensuring that all insulation fitters are fully trained and for supervising the work of fitters.
 - 1.24.6. Refrigeration pipework shall be insulation in accordance with Bulletin No. 9 – Pipework Insulation Installation Technique of the Institute of Refrigeration UK 2001.

2. SERVICES TO BE INSULATED:

2.1. Unless otherwise indicated, the following services shall be insulated:-

- 2.1.1. Heating systems, including boiler flues, pipework, calorifiers, feeds and vents, etc. but excluding any pipework or any final connections that are so located as to contribute heat to the occupied space in addition to the heat emitter.
- 2.1.2. Hot and cold water services systems including calorifiers, cylinders and storage cisterns. Final connections to draw-off points (unless requiring frost protection) and external cold water storage cisterns shall not be insulated.
- 2.1.3. Pipework, vessels, etc. in a heat recovery, refrigeration or chilled water system.
- 2.1.4. Pump bodies and pipe fittings on chilled water systems to prevent condensation.
- 2.1.5. Steam and condensate systems including accumulators, pipework, hot wells, condensate receivers and boiler blowdown pipes. Condensate cooling legs shall not be insulated.
- 2.1.6. Safety valve discharge pipes for steam, heating and hot water where required to prevent danger to personnel.
- 2.1.7. Supply air handling plant including heater or cooler batteries with intake ductwork to plant insulated to prevent condensation.
- 2.1.8. Ductwork carrying heated, cooled, tempered or conditioned supply air or extract air for use by re-circulation or for extract air forming part of a heat recovery system.
- 2.1.9. Air extract ducting to atmosphere – where such ducting passes through occupied areas and contributes to the heat gain/loss of the occupied area or where ductwork is carrying high humidity air which is liable to condense by cooling of the air within the duct.
- 2.1.10. Any pipework with heated/cold/chilled fluid, within hollow partition, 'boxed in', floor screeds and all pipework subject to potential frost conditions. Where pipework is in cavities or hollow partitions the pipework shall always be placed on the warm side of the insulation (under winter conditions).

- 2.1.11. The standard of insulation on kitchen extract ductwork shall be such as to prevent (in the event of a fire outside the ductwork) the resulting heating transfer arising any grease, on the inside surface of the duct, to its combustion temperature in accordance with Appendix D, Clause D10 of DW 172. In this connection the duct insulation shall ensure that temperature on the outside of the duct shall not exceed 140K above ambient at any point.

Fire rated kitchen extract ductwork shall comply in full with the Specification Part 3.2 (Ductwork Installation) and specifically with Clause 3.9 Kitchen Ductwork Systems and Clause 4, Fire Rated Ductwork.

- 2.1.12. Any other services or equipment detailed in Appendix 1.

3. INSULATION MATERIALS:

REF.	INSULATING MATERIAL	TYPICAL TEMP RANGE	TYPICAL 'K' VALUE W/MK AT MEAN TEMP °C	TYPICAL MATERIAL DENSITY KG/M ³
CS	Calcium silicate preformed pipe, lags and slab sections.	Up to 650°C	0.058 @ 100	Not less than 210
GF RF	Bonded preformed manmade glass/rock fibre mats and mattresses.	Up to 300°C	0.044 @ 100	GF not less than 50 / RF not less than 65
GF RF	Bonded preformed manmade glass/rock fibre pipe sections.	Up to 230°C	0.043 @ 100	GF: 80-100 RF: 130-150
GF RF	Bonded manmade mineral fibre slabs.	51°C to 400°C	0.047 @ 100	GF: 48+ RF: 65+
GF RF	Flexible mattresses.	Up to 230°C	0.065 @ 100 0.044 @ 100	GF: 20 RF: 90
PF	CFC-free Phenolic Resin (Foam) insulation. Pipe, sheet and slab sections.	-180°C to +120°C	0.02 @ 10	Not less than 35
PF	CFC-free Phenolic Block – high density pipe and duct support foam.	-180°C to +120°C	0.04 @ 50	80 to 120
ENR	Expanded nitrile rubber (Class 'O' only). Standard Class	-40°C to +110°C	0.036 @ -10 and 0.041 @ +20	Not less than 65

REF.	INSULATING MATERIAL	TYPICAL TEMP RANGE	TYPICAL 'K' VALUE W/MK AT MEAN TEMP °C	TYPICAL MATERIAL DENSITY KG/M ³
ENRHT	Expanded nitrile rubber, high temperature insulation – inherent sunlight and UV resistant, built in vapour barrier for external use.	-50°C to +150°C	0.038 @ 0 0.042 @ +40	60 to 80
UR	CFC-free Urethane Foam (pre-insulated cylinders, calorifers, vessels and tanks	Up to 110°C Maximum	0.022 @ 10 0.026 @ 40	50 to 80

Note: In selecting insulation materials account should be taken of that role which the thermal emissivity of the insulation surface finish plays in reducing or increasing heat transfer from the insulated pipe or duct, with reference to BS 5422 (2009) and BS 5970 (2012)

4. PROTECTIVE FINISHES:

4.1. INTERNAL COVERINGS:

4.1.1. Internal coverings shall be aluminium foil laminate with foil thickness 0.008mm minimum, polyethylene-glass reinforced laminated finish with a factory applied coating to achieve a Class 'O' surface spread of flame fire rating. All joints shall have minimum overlaps of 38mm longitudinal and 50mm at ends, secured with a Class 'O' self-adhesive tape or adhesive and aluminium foil strip. Both tape and strip shall be Class 'O', waterproof and a minimum of 75mm wide.

4.1.2. Internal coverings shall not be punctured by fixing devices particularly where the finish is a vapour or moisture barrier. Any cladding used over the vapour barrier shall be retained with 19mm wide aluminium bands between 300mm centres.

4.2. CLADDING:

4.2.1. Unless otherwise indicated, cladding materials shall be 1mm thick plain aluminium sheet, with all fitting joints and laps sealed with a continuous bead of sealant and secured by aluminium self-tapping screws at 50mm pitch. Aluminium bands shall be used where screws could penetrate moisture or vapour barrier. Any quick release fastening shall be either cadmium-plated or aluminium.

4.2.2. Bends, tapers, tees and other fittings shall be encased in formed aluminium sheet casings of minimum number of sections.

- 4.2.3. End joints shall be covered with 38mm wide aluminium strip and purpose made caps. Longitudinal joints on adjacent sheets shall be slightly offset, with suitable provision made for thermal expansion when fixing the protective aluminium covering. Overlaps shall be adequate to cater for the expected expansion movement, plus not less than 40mm.
- 4.2.4. With the specific approval of the Engineer, other materials may be considered such as light-grey or white rigid self extinguishing PVC film.

4.3. EXTERNAL FINISHES:

- 4.3.1. Services exposed to weather shall be finished with either:-
 - 4.3.1.1. Two layers of 2-ply bituminous (roofing) felt arranged to shed water with a minimum overlap of 75mm at all joints sealed with bituminous adhesive. The whole shall be covered with galvanised 1mm x 25mm mesh wire netting laced and drawn tight, and applied with two coats of emulsified bitumen to BS 3416 type 1 Class A.
 - 4.3.1.2. A dark grey external grade PVC sheet of minimum thickness 0.5mm with a minimum overlap of 50mm. All joints shall be secured with 12mm wide butyl tape in accordance with the manufacturer's recommendations. Stop ends shall be covered with purpose-made aluminium caps. Should the service(s) be subject to frost conditions then the insulation shall be continuous.
- 4.3.2. External services liable to impact damage shall be protected as indicated in clause 4.2 above. Aluminium sheet shall be minimum 1.9mm thick and chemically or electrically (i.e. anodized) surface treated to prevent oxidation. Added care shall be taken to prevent the ingress of water and electrolytic corrosion. Joints shall be weatherproofed by interposing tape, impregnated with petroleum jelly or soft bitumen, between the sheets at each joint or by filling the lapped joints with bitumen or polymer mastic.
- 4.3.3. With specific approval of the Engineers, alternative materials will be considered such as external grade rigid PVC file of multilayer construction with high UV and deformation resistance.

4.4. VAPOUR BARRIERS:

- 4.4.1. Thermal insulation applied to the outside of piped and ducted services, equipment and plant used to convey, store or generate fluids or gases at or below ambient temperatures, shall be provided with a water vapour barrier.
- 4.4.2. Unless otherwise indicated, the vapour barrier shall have a permeance value not exceeding 0.01g/(sMN) for chilled water pipework and equipment, 0.007g/(sMN) for refrigeration work (cold surfaces 0°C) and 0.003g/(sMN) for other applications. The material selected for the vapour barrier and its method of application shall be compatible with the thermal insulation which it is to protect.

- 4.4.3. The vapour barrier shall be applied such that it is continuous and gives protection to the whole surface of the insulation that it covers. The vapour barrier shall not be pierced or otherwise damaged.
- 4.4.4. All carbon steel pipework accepted on site from the suppliers shall be new, well formed and fully rust free. New pipework displaying areas of rust shall be rejected. Pipework shall be stored on site in dry well ventilated stores.
- 4.4.5. Prior to fitting any insulation on carbon steel glycol or chilled water pipework the pipework, flanges and any mild steel fittings or mountings shall be fully prepared to a sound base and painted with two coats of corrosion resistant paint. The low temperatures that such systems will operate at will cause a high tendency for rust to develop unless (i) all metal surfaces have been treated and (ii) the insulation and vapour barrier are fully intact.
- 4.4.6. On such systems detailed attention shall be paid to forming an unbroken continuous vapour barrier seal throughout the installation including all pipework, flanges, valves, supports and any associated mountings and fittings. In this connection attention is drawn to Figures 3, 12 and 14 of BS 5970 (2012). In all cases the vapour barrier shall be fully continuous through all walls, floors and partitions, accurately cut, neatly tailored at all take-off points, penetrations and terminations.
- 4.4.7. The Contractor shall ensure and confirm that the vapour barrier adhesive is suitable for the application and for the design life duration for the installation.
- 4.4.8. Prior to commencing work the Contractor shall submit to the Engineer a method statement covering this element of the work.

5. PARTICULAR ITEMS:

5.1. PIPEWORK SUPPORTS:

- 5.1.1. At fluid temperatures above ambient, insulation shall be continued over pipe supports and shall be sealed at the point where the hanger, clamp or other anchorage protrudes.
- 5.1.2. At fluid temperatures at or below ambient, all pipe clips and hangers shall be attached to the outside of the insulation and metal saddles shall be used to prevent crushing of the insulation.
- 5.1.3. Supports shall be so arranged as to prevent the ingress of moisture to the insulation. The supports shall be insulated from the pipeline by lining the supports with insulation of sufficient density and thermal conductivity appropriate to the duty. Generally refrigerant, chilled water and cooling water tubes shall be supported from outside the insulation and finish which shall form a continuous unbroken sealed surface. All other services may be supported from the tube surface in accordance with Clause 5.1.1.

- 5.1.4. Vapour barrier and finish shall be carried over the support liners.
- 5.1.5. All protrusions through the insulation shall be insulated from that surface for a minimum distance of twice the thickness of the insulation and all vapour seals shall be correctly applied.

5.2. DUCTWORK SUPPORTS:

- 5.2.1. Insulation of ductwork supports shall be in accordance with HVCA publication DW/144.

5.3. SUPPORT INSERTS:

- 5.3.1. Support inserts shall be load bearing insulation of the same material, or compatible with the thermal insulation of the system. Where the load bearing insulation differs from the general insulation, an adhesive compatible with both materials shall be used where adhesive is specified by the adhesive manufacturer and/or the manufacturer of the load bearing insulation. The exposed ends of pipe supports shall be protected until completion of the general insulation installation. Wooden pipe supports shall not be used due to the increased risk of condensation forming on wooden blocks and the difficulty of maintaining effective vapour barriers.

5.4. VALVE AND FLANGE COVER BOXES:

- 5.4.1. Unless otherwise indicated, insulated valve and flange cover boxes shall be included for the following services:-

Chilled Water, Refrigeration, Cold Water Services	:	15mm pipe and above – all valves and all flanges and pump casings
Steam, Heating, Hot Water Services	:	15mm pipe and above – all valves and flanges
Condensate, Fuel Oil	:	25mm pipe and above – all valves and flanges
All external services and services in 'cold' roof spaces	:	15mm pipe and above – all valves and flanges.

- 5.4.2. Cover boxes shall comprise an aluminium split casing fitted with spring clip fasteners and lined with an insulation material (thickness to be equal to that on pipework) suitable for the particular service.
- 5.4.3. Cover boxes shall be suitable for the size and type of valve or flange and be neatly and properly finished. They shall be capable of being dismantled without damage to the adjacent pipe insulation. All joints in the casings shall be suitably sealed.

- 5.4.4. A complete vapour seal shall be maintained between permanent and removable insulation and the vapour barrier seal shall return to the pipework on either side of the flange or valve.
- 5.4.5. The glands on valve spindles shall project beyond the insulation.
- 5.4.6. External valve and flange boxes shall be suitably weatherproofed and sealed as for the pipework to which they are attached.
- 5.4.7. In general cladding cover boxes to valves, flanges and other fittings shall comply with Section 28 and 29 of BS 590 (2012).
- 5.4.8. Only with the express approval of the Engineers and where the project is non-industrial and the application is appropriate, valves, flanges and other fittings and mounting may be insulated and finished with proprietary fabric bags / insulation jackets. Such coverings shall comply in all respects with the current Irish Building Regulations and the accompanying Technical Guidance documents, with BS 9999 (2017) and BS 476 (2014). Such arrangements shall be used only where the pipework itself is not finished in aluminium sheet. Jackets shall be custom made, durable and expressly designed for repeated removal and re-instatement for maintenance purposes. Such products shall employ adjustable draw cords and fasteners as appropriate to ensure a close fit which follows the shape and contours of the fittings and results in, when complete a neat, well tailored, professional finish which is well integrated with adjoining pipework insulation covers shall ensure when enclosing heating surface and external surface temperature not exceeding 50°C.

5.5. DUCTWORK FLANGES:

- 5.5.1. Insulation shall be applied to all ductwork sides using insulation sections the same as the adjacent ductwork and shall be suitably sealed with 100mm wide aluminium foil tape.

5.6. EXPANSION JOINTS:

- 5.6.1. Expansion joints shall be insulated with the same material and thickness as that used for adjoining pipework. In addition, for temperatures at or below ambient, expansion joints shall have a vapour barrier sealed over the insulation. A complete vapour seal shall be made between the pipework and the expansion joint insulation and the vapour seal shall return to the pipework on either side of the expansion joint. Insulation shall not be applied until any 'cold draw' has been taken up.

5.7. INSULATION IN EXTERNAL TRENCHES/DUCTS:

- 5.7.1. Insulation in external covered trenches or ducts shall be calcium silicate or phenolic foam insulation sections, with aluminium foil outer finish, and shall be suitably weatherproofed in trenches/ducts liable to flooding.

5.8. INSULATION IN FLOOR DUCTS/SCREEDS:

- 5.8.1. Pipework installed in floor ducts shall be calcium silicate, phenolic foam or mineral fibre sections as applicable, with aluminium foil outer finish.
- 5.8.2. Pipework installed in floor screeds shall be insulated and protected in such a manner as to allow free movement of the pipes and to protect pipe surfaces from any chemical damage caused by the floor screed.
- 5.8.3. Pipework shall be insulated separately and adjacent parallel pipes shall not be insulated together in one application. Sufficient space shall be allowed for clearance between services to allow for the thickness of insulation and finish.

5.9. EQUIPMENT INSULATION:

- 5.9.1. Equipment shall be insulated using preformed rigid sections, bevelled lags or plain flat slabs radiussed and bevelled as necessary to fit snugly and fixed in place at suitable intervals with non-ferrous metal or plastic fixings. All open joints, cavities and irregularities shall be filled with insulation of the same material as the sections. Vessel domed or dished ends shall be insulated using fully tailored insulation segments.
- 5.9.2. Equipment to be insulated generally includes heat exchangers, tanks, vessels, hot wells, steam and condensate receivers, flues, heater and cooler battery casings and system components. All mechanical plant, which is not fire insulated by the manufacturers and in which the uninsulated surface temperature is above or below ambient, shall be insulated.
- 5.9.3. Removable covers shall be provided on vessel maintenance manholes as detailed below, and inspection hand holes and vendors nameplates shall be left exposed.
- 5.9.4. The Contractor shall make adequate provision, particularly on vertical faces, to prevent the insulating material from sagging i.e. by using insulation pins and discs attached to the walls of the equipment.

5.10. PLANT/EQUIPMENT ACCESS:

- 5.10.1. Plant/equipment access shall comprise aluminium sheet covering or steel sheet with aluminium and zinc coating, securely fixed to the insulation in an approved manner and neatly joined and shaped to suit the plant/equipment contours. Where removable access or sections are incorporated on the plant/equipment, the insulation and covering shall be removable from the relevant area without disturbing the remainder of the insulated surface by means of quick release type fasteners.

5.11. BOILER FLUE DUCTING:

- 5.11.1. Insulation for boiler flue ducting shall be by metal mesh supporting manmade mineral fibre mattress suitable for the temperature and faced on both sides with 25mm galvanised wire mesh, stitched with wire. The mattresses shall be supported all over on the expanded metal mesh with mild steel studs, nuts and washers at 300mm pitch throughout, to provide a 25mm continuous air space. The mattresses shall be flush fitting and secured by means of galvanised wire netting, 25mm mesh by 0.7mm diameter wire.
- 5.11.2. The finish covering shall be aluminium sheeting of 1.2mm minimum thickness with joints secured with self-tapping cadmium-plated screws or pop rivets. Insulation and sheeting over flanges/joints and inspection covers, etc. shall be easily removable for inspection/maintenance purposes. On external flues, etc. the aluminium sheeting shall be 1.9mm and arranged to shed water and all overlaps/joints except expansion joints shall be sealed.

5.12. ELECTRIC TRACING OF WATER SERVICES PIPEWORK:

- 5.12.1. Pipework in exposed extreme situations (such as roofs, north-facing walls, gantries, etc.) shall be protected with electric tracing in addition to the specified thermal insulation.
- 5.12.2. The Contractor shall supply, install, test and commission a proprietary trace heating system complete with all controls necessary for its operation. The system shall be rated at 230V/50Hz, with an IP rating suitable for the location. The electrical contractor shall be responsible for providing an electrical supply to the trace heating system.
- 5.12.3. Unless otherwise indicated, electrical tracing tape rated at 16W/m shall be used on pipework of 50mm (and below) in diameter and tape rated at 25W/m shall be used on pipework of 65mm diameter and above. Maximum circuit length shall be 100m. The tape shall be attached to the pipe surface in accordance with manufacturer's instructions.
- 5.12.4. Each 100m length of trace heated pipework shall be individually isolated with an external specification isolator, adjacent to the treated pipework for maintenance purposes. Each 100m length shall also be supplied from an individual MCB / RCD, and labelled to identify the section of treated pipework supplied. On larger treated pipework installations a dedicated trace heating panel shall be provided.
- 5.12.5. Trace heating tape shall be self-regulating by raising heat output as the temperature of the fluid being protected falls and reducing heating output as the temperature rises. The system shall be controlled by an ambient thermostat set to activate the tapes at 5°C and de-activate the tapes at 10°C. The system shall be complete with all necessary contactors.

- 5.12.6. On completion the entire system shall be commissioned and certified by the suppliers. If necessary the ambient thermostat shall be temporarily by passed to facilitate operation of the system at the time of commissioning.
- 5.12.7. The frost protection system shall be designed by the supplier on the basis that the contents of the pipework shall be maintained in a liquid state (when the fluid is stationary) at or above a fluid temperature of +4°C at all times down to an external ambient temperature of -12°C.
- 5.12.8. Prior to installation, the Contractor shall submit details of the proposed trace heating system to the Engineer for approval.

6. TABLE OF MATERIALS:

- 6.1. Unless otherwise indicated, the following combined thermal insulation materials and finishes shall be provided. Alternative materials may only be used with the written approval of the Engineer.

SYSTEM	INSULATION MATERIAL (REF. CLAUSE 3)	LOCATION	FINISH MATERIAL
Steam HTHW MTHW Condense	GF/RF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt / Aluminium sheet
LTHW	GF/RF or PF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt / Aluminium sheet
Chilled Water	PF or GF/RF (with approval of Engineer)	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt / Aluminium sheet
Domestic Water Services	GF/RF or ENR	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
Refrigerant	ENR	Plant room	-
		Internal-exposed	-
		Internal-concealed	-
		External	ENR with inherent UV protection ⁽¹⁾
Fresh Air Intake (FAI) Supply Air (SA) Return Air (RA) Extract Air (EA) Exhaust Air (ELA) Passive Transfer Air (PTA) All the above duct services to be insulated except where expressly agreed on site with the Engineer	GF/RF or PF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt / Aluminium sheet / External grade PVC ⁽²⁾

- (1) ENR grade with inherent UV protection and built in vapour barrier and which can be installed externally without additional protective measures.
- (2) Dark grey external grade PVC sheet as per Clause 4.3.1.2 of this specification and with specific approval of the Engineer.

7. INSULATION THICKNESS:

Thickness based on glass/rock fibre insulation except where indicated.

SERVICE	INSULATION TYPE	TABLE REF BS 5422 (2009)	MILD STEEL TUBE NOMINAL INTERNAL DIAMETER												
			15	20	25	32	40	50	65	80	100	150	200	250	300
Steam HTHW Condensate	GF/RF	23	50	50	60	60	60	70	70	80	80	100	100	100	120
MTHW	GF/RF	23	30	30	30	40	40	40	40	50	50	60	60	60	60
LTHW	GF/RF	21	30	30	40	40	40	40	40	40	50	50	50	50	50
	PF		15	15	20	20	20	20	25	25	25	30	30	30	30
Chilled Water	PF	8	15	20	20	20	25	25	25	25	30	30	35	35	35
	GF/RF		30	40	40	40	50	50	50	50	60	60	70	70	70

SERVICE	INSULATION TYPE	TABLE REF BS 5422 (2009)	COPPER TUBE NOMINAL; EXTERNAL DIAMETER							
			15	22	28	35	42	54	76	108
Domestic Water Services (applicable also to thermal solar panels at c.60C)	GF/RF	20	25	30	30	40	40	40	50	50
	ENR		25	30	30	40	40	40	50	50
	PF		15	15	15	20	20	20	25	25
Refrigerant	ENR	9	30	35	35	40	40	40	50	50

Note : All insulation thicknesses in intervals of 10mm except for Phenolic Foam which is in intervals of 5mm – in recognition of its superior thermal conductivity.

FUNCTION	INSULATION TYPE	TABLE REF BS 5422 (2009)	THICKNESS OF INSULATION mm
To control condensation	GF/RF	12	50 mm K = 0.035 W/mK
	PF	12	30 mm K = 0.020 W/mK
Duct Conveying Warm Air Only (35C approx.)	GF/RF	13	50 mm K = 0.035 W/mK
	PF	13	30 mm K = 0.020 W/mK
Duct Conveying both Warm and Cold Air – dual purpose (13 C to 35C approx.)	GF/RF	14	50 mm with high emissivity finish (dull dark surface) 50 mm with low emissivity finish (bright shining surface) K = 0.035 W/mK
	PF	14	33 mm K = 0.020 W/mK
Boiler Flue Duct	RF	1 BS5970:2012	100 mm rockwool wired mattress to BS EN 14303 capable of up to 850°C maximum service temperature

8. EQUIPMENT INSULATION AND THICKNESS:

ITEM OF EQUIPMENT	LOCATION	INSULATION MATERIAL (REF. CLAUSE 3)	THICKNESS (mm min.)	FINISH MATERIAL
Heating Calorifiers	Any area	GF/RF	100	Aluminium sheet
HWS Calorifiers	Any area	GF/RF	75	Aluminium sheet
Condensate Receivers	Any area	GF/RF	100	Aluminium sheet
Chilled Water Tanks	Any area	PF GF/RF	40 100	Aluminium sheet and vapour barrier
Hotwells	Plantroom	RF/GF	100	Aluminium sheet / Reinforced aluminium kraft foil
Cold water storage tanks	Any internal area	PF	40	Reinforced aluminium kraft foil
Heat Exchangers	Any Area	GR/RF	100	Aluminium sheet

SECTION 3 - STANDARD SPECIFICATION

PART 3.13 - LABELLING AND IDENTIFICATION

1. GENERAL:

- 1.1. The following specification covers the requirements for labelling and identification of ductwork, pipework, valves and equipment.
- 1.2. The Contractor shall be responsible for assigning identification references to valves, plant and equipment, individual circuit control devices, etc. in accordance with the numbering/referencing system used in the record documentation.
- 1.3. Sample identification labels shall be submitted to the Engineer for approval.
- 1.4. Care shall be taken to ensure that the label material is suitable for the temperature of the surface to which it is to be attached.

2. DUCTWORK AND PIPEWORK IDENTIFICATION:

- 2.1. Unless otherwise indicated, all distribution services shall be colour coded and provided with symbols for identification purposes. Identification coding for ductwork, including thermal insulation, shall be in accordance with HVCA publication DW/144. For pipework, including thermal insulation, the basic colour and colour coding shall be in accordance with BS 1710.
- 2.2. Proprietary PVC identification bands or triangles shall be securely fitted to pipework throughout the building. These shall identify the service and shall be fitted in the following locations unless otherwise indicated:-
 - 2.2.1. Both sides of each valve.
 - 2.2.2. At each change in direction.
 - 2.2.3. At each branch connection.
 - 2.2.4. At each floor level in vertical service ducts.
 - 2.2.5. On all horizontal runs at a minimum of 4m intervals.
 - 2.2.6. Both sides of any wall or partition through which the pipe passes.

- 2.3. In addition to colour bands or triangles and unless otherwise indicated, all ductwork and pipework in plant rooms, service areas, ceilings and floor voids, whether insulated or not, shall be identified with black or white letters to show the type of service and direction of flow. Services shall be shown as follows:-

Fresh air	FA	Steam	Steam
Supply air	S	Condensate	COND
Return air	R	LTHW Heating	LTHW
Exhaust air	E	MTHW Heating	MTHW
Mains water service	MWS	HTHW Heating	HTHW
Cold water service	CWS	Chilled water	CHW
Hot water service	HWS	Condenser water	CONDW

The letters F and R shall be added to piped distribution to show flow and return respectively.

- 2.4. Arrows indicating direction of flow shall also be applied after joints, intersections, etc. and on straight runs at intervals not exceeding 16m.

3. PLANT IDENTIFICATION:

- 3.1. The Contractor shall supply and install identification labels for all items of plant and equipment. The label shall indicate the item of plant and its reference number which shall be consistent with all record documentation.
- 3.2. Identification labels shall be engraved traffolite with black printing in capital letters, 8 mm high on a white background. Labels shall be securely fixed, in a visible position, to the item of plant. Labels shall be mechanically fixed, adhesive fixing will not be accepted.

4. DRINKING WATER IDENTIFICATION:

- 4.1. The Contractor shall mount an ivory label clearly marked "Drinking Water" all drinking points.

5. VALVE IDENTIFICATION:

- 5.1. The Contractor shall supply and install valve identification discs for all valves, which shall be attached to valves by means of brass chains.

- 5.2. The valves shall be readily identifiable by numbers, which shall be consistent with all record documentation.
- 5.3. Identification discs shall be engraved traffolite 35mm dia. discs and shall indicate the particular service by colour code and the number of the valve relating to the layout of the particular installation.

SECTION 3 - STANDARD SPECIFICATION

PART 3.14 - INSPECTION, TESTING AND COMMISSIONING

1. GENERAL:

- 1.1. Preliminary checks, cleaning, setting to work and regulation of the individual systems shall generally be in accordance with the relevant parts of the following publications:-
 - 1.1.1. CIBSE Commissioning Codes (Series A, B, C, R and W).
 - 1.1.2. BSRIA Application Guide AG1/91: Commissioning of VAV Systems in Buildings.
 - 1.1.3. BSRIA Application Guide AG8/91: Pre-commission Cleaning of Water Systems.
 - 1.1.4. BSRIA Application Guide AG2/89: The Commissioning of Water Systems in Buildings
 - 1.1.5. HVCA TR/6: Guide to good practice for site pressure testing of pipework.
 - 1.1.6. HVCA DW/TM2: Internal cleanliness of new ductwork installations.
 - 1.1.7. HVCA publication DW/143: A practical guide to ductwork leakage testing.
- 1.2. Any defects of workmanship, materials, performance, design of equipment, maladjustments or other irregularities which become apparent during inspection, testing or commissioning shall be rectified and the relevant part of the re-testing or commissioning procedure shall be repeated at the Contractor's expense.
- 1.3. The Contractor shall supply sufficient lubricating oil and other consumable materials to allow the complete commissioning and testing of the equipment within his scope.
- 1.4. The Contractor shall refer to the General Conditions for details of the attendance being provided within the programme period agreed at the commencement of works.
- 1.5. The Contractor shall be responsible for ensuring that tests by nominated suppliers are properly carried out.
- 1.6. All pipework and ductwork shall be tested as soon as practicable after installation and before completion of shaft walls, access panels, suspended ceilings and the application of any insulation.

- 1.7. The Contractor shall be responsible for the provision of all apparatus and instruments required for testing and commissioning. Recent calibration certificates must be provided for all instruments used. The accuracy of the test instruments and methods shall be demonstrated to the Engineer where required.
- 1.8. Unless otherwise indicated, the Contractor shall give a minimum notice of 7 days prior to all tests, on or off site, in order that the Engineer, at his discretion, may be represented at such tests. Both the Contractor and the Engineer's representative shall sign the test certificates which shall be prepared by the Contractor and retained until completion of the works.
- 1.9. The Contractor shall ensure that sufficient time is allowed in the Main Contractor's programme to carry out the testing, commissioning and hand-over of the installation.

2. INSPECTION:

- 2.1. Throughout the execution of the works, the Contractor shall be responsible for ensuring compliance with all relevant Specifications, Regulations, Safety Codes and Local Authority requirements and shall notify the Engineer of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the installation whether or not such infringement relates to the works covered in this Specification or to the associated works of others.
- 2.2. Where an inspection is required by an authority other than the Engineer, the Contractor shall inform the Engineer of the place and date fixed for such inspections.
- 2.3. The Engineer reserves the right to make any inspections. Equipment and installations shall be made available during design, fabrication, construction, installation and commissioning for inspection by the Engineer as required. Such inspections shall not relieve the Contractor from full responsibility for the quality and correctness of his work.

3. CLEANLINESS:

3.1. PIPEWORK DISTRIBUTION SYSTEMS:

- 3.1.1. Items for incorporation in the works shall be kept in protective storage until needed. Tubes and equipment shall be kept effectively plugged, capped or sealed until required.
- 3.1.2. Before installations are commissioned and subjected to the required tests they shall be thoroughly cleaned internally and externally.
- 3.1.3. Arrangements to ensure cleanliness of systems shall follow the recommendations of the relevant codes and where indicated chemical cleaning of water systems shall be carried out as required.

- 3.1.4. Effluent from cleaning processes shall be disposed of in compliance with the requirements of the local Water Authority.
- 3.1.5. Internal cleaning for gas installations and steam and condensate installations shall include scavenging with steam or oil-free compressed air to the satisfaction of the Engineer. Items which could be damaged by scavenging shall be isolated and cleaned by approved alternative methods.
- 3.1.6. Fuel oil installations shall be cleaned by steam or flushing with water at velocities not less than 1.5 m/s. Water flushing shall include detergent treatment as required.
- 3.1.7. Heating and chilled water systems shall be thoroughly flushed out with clean water to remove all foreign matter to the satisfaction of the Engineer and in accordance with BSRIA-AG8/91.
- 3.1.8. Unless otherwise indicated, heating and chilled water pipework shall be chemically cleaned in accordance with BSRIA-AG8/91.
- 3.1.9. Water services systems shall be flushed, cleaned and disinfected as required in accordance with BS 6700.

4. NON-DESTRUCTIVE TESTING:

- 4.1. Welds in MTHW, HTHW and steam pipework, and in LTHW pipework which is to be concealed, shall be subjected to non-destructive testing (Class II Welding) by ultrasonic, radiographic, or other approved methods as follows:-
 - 4.1.1. The entire circumference of 10% of the butt and branch welds made by each welder, selected at random with a minimum of one weld per welder.
 - 4.1.2. The acceptable limitations in faults revealed by non-destructive testing shall be as specified in HVCA TR/5, BS 2971 or BS 2640, as appropriate.
 - 4.1.3. In the event of any butt or branch weld failing to meet the requirements of Class II welding, defects in such welds shall be rectified. The Engineer may call for an increase in the number of non-destructive tests called for in 4.1.1. until such time as a satisfactory standard is reached.
- 4.2. For working pressures over 2 bar up to and including 5 bar, manufactured and natural gas pipework shall be subjected to non-destructive testing as outlined in 4.1.1. to 4.1.3. above, with the exception of welded joints in buried steel pipework. Generally for working pressures up to and including 2 bar, butt and branch welds shall not be subjected to non-destructive testing, except where pipework is within ventilated closed ducts, where all welded joints shall be so tested. Where gas pipework rises in buildings over 20 storeys high, the Engineer may call for non-destructive testing of more than 10% of welded joints.

5. PRESSURE TESTING:

- 5.1. The Contractor shall ensure that any item which is not designed to withstand the test pressure is not included in pressure tests. In addition, the Contractor shall ensure that pumps, filters, tanks, and other items of equipment are excluded from pressure tests.
- 5.2. Boiler plant, tanks, cylinders, pumps, etc. specified to comply with Irish, European and British Standards shall be subject to such tests at works as are provided for in the relevant Standard. Where there is no such Standard, such plant shall be subjected to a hydraulic test at works of 1.5 times the maximum working pressure, or of 1.5 bar, whichever is the greater, for a minimum period of 2 hours. Test certificates for works tests required by such Standards shall be included in the record documentation.
- 5.3. On completion of cleaning operations, heating, chilled water, steam, condensate, hot and mains water service pipework distribution systems shall be subjected to hydraulic pressure tests 1.5 times the working pressure for a minimum of 2 hours and to the satisfaction of the Engineer. After satisfactory tests, systems shall be drained, dried, filled with preserving solution or with treated water as indicated.
- 5.4. After being cleaned, manufactured and natural gas installations shall be tested for soundness and purged in accordance with the requirements of IS 820.
- 5.5. After being cleaned, cold water systems shall be recharged with clean water and storage cisterns and distributing pipework shall be watertight under working conditions of pressure with all draw-off taps closed. Underground water mains shall be subjected to a hydraulic test pressure in accordance with local authority requirements.
- 5.6. After being cleaned, fuel oil pipework systems shall be hydraulically tested to 1.5 times the working pressure or 7 bar, whichever is the greater, for a minimum period of 2 hours. Suction lines that may be subjected to sub-atmospheric pressure shall be tested as detailed in BS 5410.
- 5.7. Fire protection installations shall be tested in accordance with BS 5306, as appropriate.
- 5.8. Unless otherwise indicated, low- and medium-pressure ductwork constructed and installed in accordance with DW/144 shall not be tested for air leakage. Low- and medium-pressure ductwork shall be subjected to a visual inspection only for verification of acceptable airtight construction. High-pressure ductwork shall be tested in accordance with the requirements of DW/143.
- 5.9. Installations or sections of air or water distribution systems which will be embedded in the structure or concealed in permanently sealed ducts, trenches, roof spaces, etc. shall, in addition to the tests specified above, be individually tested as they are laid and before being embedded or concealed.

6. COMMISSIONING:

- 6.1. The Contractor shall be responsible for proving the performance of all equipment and installations, and for the correct balancing of air and water systems, in accordance with the relevant codes.
- 6.2. The entire commissioning procedure shall be undertaken by the Contractor's specialist staff or by a competent independent commissioning specialist nominated by and acting for the Contractor. The Contractor must obtain the Engineer's approval of the commissioning specialist.
- 6.3. The Contractor shall submit samples of the commissioning specialist's test sheets to the Engineer for comment.
- 6.4. Unless otherwise indicated, the Contractor shall submit a commissioning schedule and programme to the Engineer at least 6 weeks before commencement of commissioning.
- 6.5. Commissioning shall include:-
 - 6.5.1. Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start-up.
 - 6.5.2. Preliminary setting and adjustment of all plant and equipment consistent with eventual design performance.
 - 6.5.3. Energising and setting to work of all plant.
 - 6.5.4. Final regulation and demonstration that the installation delivers the correct air and fluid flow rates at the specified conditions. Flow rates shall be within 95% and 110% of design, unless otherwise indicated.
- 6.6. The various alarms and safety devices on all installations shall be systematically checked through and simulated fault conditions created to ensure the adequacy of the interlocking alarm circuits.
- 6.7. Commissioning shall be carried out to the satisfaction of the Engineer, who reserves the right to witness commissioning procedures. The results shall be recorded on suitable sheets, which shall be signed by the Contractor and endorsed by the Engineer.

7. PERFORMANCE TESTING:

- 7.1. Where indicated, the Contractor shall subject the entire plant to a total continuous run of the duration indicated to ensure that all apparatus, materials and systems are working properly; that all controls, safety devices, etc. are operating correctly, that design temperatures in the piping and air systems are established; that the systems provide the required internal conditions and to assure himself that the design intent is achieved before demonstration to the Engineer. Should the plant not be in proper operating condition, the Engineer reserves the right, where defects persist, to employ others to carry out remedial work and put the systems in proper working order, at the Contractor's expense.

8. DEMONSTRATION AND HAND-OVER:

- 8.1. The Contractor shall include for the requisite man-hours for the demonstration, instruction and hand-over of the mechanical services installation to the Employer.
- 8.2. The Contractor shall ensure that record documentation is handed over to the Employer two weeks prior to demonstration.

SECTION 3 - STANDARD SPECIFICATION

PART 3.15 - RECORD DOCUMENTATION

1. GENERAL:

- 1.1. The following specification covers the preparation and supply to the Engineer of four sets of record documentation, incorporating the following:-
 - 1.1.1. Operating and maintenance manual(s).
 - 1.1.2. Record drawings.
 - 1.1.3. Testing, commissioning and proving reports.
- 1.2. The documentation shall be written, assembled and completed in accordance with the requirements of EN 82079-1 : 2012, "Technical manuals", and BSRIA AG 1/87, "Operating and maintenance manuals for building services installations".
- 1.3. The Contractor shall be required to demonstrate during the course of the works that adequate and accurate records are being maintained and that record documentation is being progressively compiled.
- 1.4. Where information is required from material or plant suppliers/manufacturers the Contractor shall request such details from the relevant company. The Contractor shall allow for any charges that may be required by manufacturers or suppliers for the provision of information and literature.
- 1.5. The Contractor shall issue a draft copy of the record documentation to the Engineer for approval 6 weeks before the planned practical completion of the project.
- 1.6. The final documentation shall be capable of being used without other supporting information.
- 1.7. Of the four sets, three complete sets of documentation shall be provided to the Engineer on practical completion and one complete set shall be supplied by the Contractor to the Project Safety Officer.

2. PRESENTATION:

- 2.1. The manual(s) shall be presented in a format which allows for three levels of reader ability:-
 - 2.1.1. Non-technical (those who use or occupy the building).
 - 2.1.2. General technical (those responsible for managing the operation and maintenance of the building).
 - 2.1.3. Specialists (those who maintain the building).
- 2.2. The manual(s) shall be A4 size, hard bound, and shall comprise a loose leaf system.
- 2.3. Manual details, logos, addresses and other relevant information shall be provided on the front cover and on the spine if space permits.
- 2.4. An information sheet shall be provided at the front of the manual(s) listing the names and addresses of the principals involved on the contract.
- 2.5. The manual(s) shall be arranged with an index and referencing system, with numbered card dividers between sections.
- 2.6. The paper used in the final issue shall be good quality, white, 120 g/m², and the reproduction method shall be dry photocopy.
- 2.7. All documentation shall be written in English. The text of descriptive sections shall be kept concise while at the same time ensuring completeness.
- 2.8. Jargon shall be avoided. New terms shall be defined when first introduced. Abbreviations shall only be used if they have been defined or their meaning is clear from the text.
- 2.9. Illustrations, drawings and diagrams incorporated into the manual(s) shall be easily read in conjunction with the relevant text.
- 2.10. The instructions applicable to the project shall be highlighted by the Contractor on the initial copy for the Engineer's approval, and on all four final copies.

3. CONTENT AND LAYOUT:

- 3.1. The manual(s) shall follow the framework set out in Part I of BSRIA AG 1/87 and shall include purpose and planning information, technical documentation including record drawings, full operating instructions for each system, detailed maintenance instructions and schedules, emergency information, parts lists, modification instructions, disposal instructions, manufacturers' literature, together with procedures and results of all tests undertaken during the testing and commissioning process.

4. RECORD DRAWINGS:

- 4.1. The drawings shall be prepared by CAD to A0 or A1 size and each drawing shall be clearly marked "record drawing".
- 4.2. Record drawings shall be executed by a competent draughtsman and shall contain sufficient detail to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the works.
- 4.3. Lettering on drawings shall be to an approved lettering system and the title block shall be to the Engineer's approval.
- 4.4. The title block shall not contain any revision notes or references, nor shall the drawings contain any references to existing services or similar notes.
- 4.5. The drawings shall clearly show all systems, plant, valves, dampers, etc. All plant and valves shall be clearly referenced and shall be readily identifiable.
- 4.6. The Contractor shall ensure that any services which are buried within the structure, or underground, are precisely located on the drawings, along with the precise positions of entry of services to the building, giving their depth and the locations of the relevant isolating valves and cocks.
- 4.7. The drawings shall incorporate all building changes which may have occurred during the course of the contract.
- 4.8. The Contractor shall provide the following for inclusion in the manual(s):-
 - 4.8.1. A schedule of record drawings, including those issued by manufacturers or suppliers during the course of the works, e.g. control panel wiring diagrams.
 - 4.8.2. A complete set of drawings, in numerical order, reduced to A3 size and printed on good quality paper identical to that used for the remainder of the manual(s).

- 4.8.3. Any isometric or diagrammatic drawings.
- 4.8.4. Copies of valve identification charts.
- 4.9. The Contractor shall provide computer disks/CDs containing the record drawings to the Autocad Release version requested by the Engineer.
- 4.10. The Contractor shall provide one copy of each of the valve identification charts and of all plant room drawings, including system schematics, mounted on suitable board. The mounted drawings shall be heat sealed or fixed in glazed hardwood frames, for installation in locations to be agreed on site.

5. COMPLETION CERTIFICATES:

- 5.1. The Contractor shall submit the following certificates when the installation is completed and include copies in the manual(s):-
 - 5.1.1. Certificate or statement of compliance in full with specification.
 - 5.1.2. Certificate or statement of completion for entire installation.
 - 5.1.3. Certificate or statement that installation complies with requirements of local fire officer and local authorities.
 - 5.1.4. Certificates required by the Employer's insurers, e.g. for pressure vessels.
 - 5.1.5. All system testing and commissioning certificates and results for the following as a minimum.
 - 5.1.5.1. Certificates from suppliers or manufacturers stating that equipment (plant & terminals) has been installed and commissioned satisfactorily and is operating in accordance with the design requirements.
 - 5.1.5.2. Certificate from controls supplier, stating that controls have been commissioned and stating the settings at which various controls have been operated.
 - 5.1.5.3. Pressure test certificates for all heating, steam, condensate, chilled, water services, gas, soils & wastes and other pipework.
 - 5.1.5.4. Leakage test certificates for ductwork where applicable.
 - 5.1.5.5. Flushing, cleaning and disinfecting certificates for all water services installations.
 - 5.1.5.6. Flushing and chemical cleaning certificates for all heating, steam, condensate and chilled water installations.

- 5.1.5.7. Certificate for cleaning of all ductwork installations and provision of cleaning doors for same as specified.
- 5.1.6. Safe Electric or appropriate governing body sub-system certificates.
- 5.1.7. An IOU (incomplete, outstanding or unsatisfactory work) shall be attached to a certificate in the event of any work not required at hand-over stage, and a programme agreed for the completion of works.

APPENDIX 1

PARTICULAR ADDENDA TO SPECIFICATION

None applicable

APPENDIX 2

EQUIPMENT SCHEDULES

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ITEM:	Mains Water Break Tank	ISSUE: Tender	REV: C01
REF DRG NO:	M-300	DATE: May 2026	REF: WT

<u>Ref. No.</u>	<u>Location</u>	<u>Service</u>	<u>Type</u>	<u>Capacity</u> (litres)	<u>Nominal Size</u> (mL x mW x mH)
WT-0.01	Packaged Plantroom (Academic Building)	MWS	Sectional [Internal]	9,500	3m x 2.5m x 1.5m

NOTES:

- All water storage tanks shall be as manufactured by Killarney Plastics Ltd. or equivalent.
- All water storage tanks shall be pre-insulated to format 30 supplied complete with lid and access doors for maintenance, ball-cock and all valves as per drawings.
- The potable water storage tanks shall be provided with the following equipment and pipework connections:
 - 2 No. ball valves
 - 2 No. early warning pipes with mesh screen
 - 2 No. suitably sized overflows with mesh screen
 - 2 No. drains c/w hose union connections
 - 2 No. Heavy duty fixed access panels
 - 1 No. Splitter panel
 - 2 No. flanged cold water outlets
- All underwater bolts, tie bars, joiners etc. shall be fabricated from grade 316 S16 stainless steel. All external bolts shall be fabricated from mild steel to BS 3692 and galvanized to BS 729.
- The lid assembly shall be fabricated from heavy quality potable water grade GRP panels with vertical supports at each panel intersection. The supports shall be fixed to both lid and base panels with 316 S16 stainless steel straps and the lid shall be provided with a 610x610 heavy duty GRP access panel located above the ball valve connection.
- The tank shall be insulated on the sides and lid. The insulation material shall be of rigid closed cell 25mm thick polyurethane foam, having a protective GRP skin securely fixed and sealed to the tank panel surface by means of a gasket type seal. All pipe cut outs shall be provided with vessels of the same material securely fitted and sealed to both the outer skin and panel face. All thermal insulation shall be in accordance with Format 30 finish, or equal and approved.
- The mechanical contractor shall provide 150x100 painted RSJ supports beneath each transverse joint and beneath each end. In each case the RSJ support shall extend the full width of the tank including flanges.
- The mechanical contractor shall not leave the tanks unattended during the initial water fill operation. The tanks shall be commissioned in accordance with BS 6700.
- Each sectional tank shall be provided with 2 no. 1m x 1m spare GRP panels which shall be left in the tankroom for Hospital use.
- This schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Cold Water Storage Tank	ISSUE: Tender	REV: C01
REF DRG NO:	M-301	DATE: May 2026	REF: CWT

<u>Ref. No.</u>	<u>Location</u>	<u>Service</u>	<u>Type</u>	<u>Capacity</u> (litres)	<u>Nominal Size</u> (mmL x mmW x mmH)
CWT-0.01	Academic Centre (Roof)	CWS	GRP (One Piece)	700	1645mm x 1035mm x 590mm

NOTES:

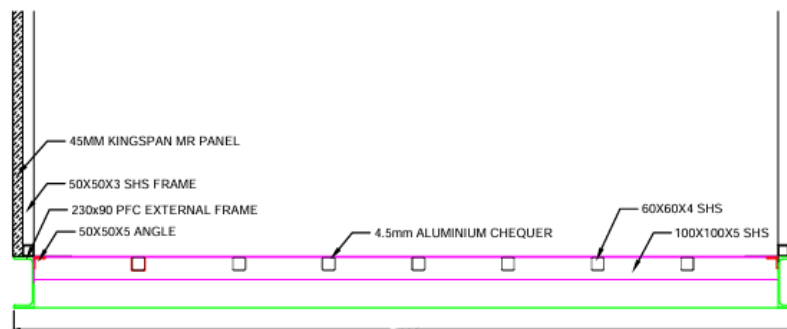
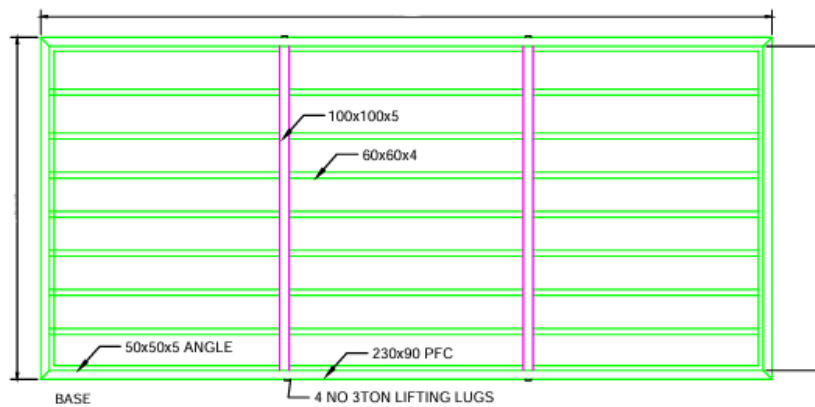
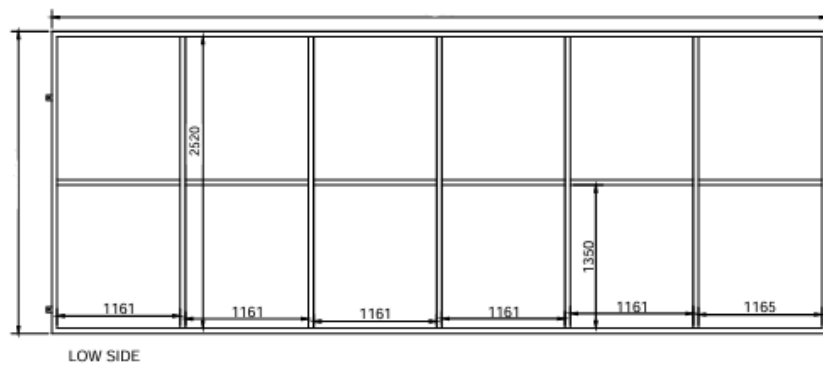
- All water storage tanks shall manufactured by Tricel Ltd. or equivalent.
- All water storage tanks shall be pre-insulated to format 30 supplied complete with lid and access doors for maintenance, ball-cock and all valves as per drawings. 1
- The potable water storage tanks shall be provided with the following equipment and pipework connections:
 - 1 No. ball valves
 - 1 No. early warning pipes with mesh screen
 - 1 No. suitably sized overflows with mesh screen
 - 1 No. drains c/w hose union connections
 - 1 No. Heavy duty fixed access panels
 - 1 No. Splitter panel
 - 1 No. flanged cold water outlets
- All underwater bolts, tie bars, joiners etc. shall be fabricated from grade 316 S16 stainless steel. All external bolts shall be fabricated from mild steel to BS3692 and galvanized to BS 729.
- The lid assembly shall be fabricated from heavy quality potable water grade GRP panels with vertical supports at each panel intersection. The supports shall be fixed to both lid and base panels with 316 S16 stainless steel straps and the lid shall be provided with a 610x610 heavy duty GRP access panel located above the ball valve connection.
- The tank shall be insulated on the sides and lid. The insulation material shall be of rigid closed cell 25mm thick polyurethane foam, having a protective GRP skin securely fixed and sealed to the tank panel surface by means of a gasket type seal. All pipe cut outs shall be provided with vessels of the same material securely fitted and sealed to both the outer skin and panel face. All thermal insulation shall be in accordance with Format 30 finish, or equal and approved.
- The mechanical contractor shall provide 150x100 painted RSJ supports beneath each transverse joint and beneath each end. In each case the RSJ support shall extend the full width of the tank including flanges.
- The mechanical contractor shall not leave the tanks unattended during the initial water fill operation. The tanks shall be commissioned in accordance with BS 6700.
- Each tank shall be provided with 2 no. 1m x 1m spare GRP panels which shall be left in the tankroom for Hospital use.
- This schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Packaged Plantroom	ISSUE: Tender	REV: C01
REF DRG NO:	M-300	DATE: May 2026	REF: PP

- | | |
|-------------------|---|
| 1. Dimensions | 4,750mm (L) X 4,500 mm(W) X 2,500MM(H) |
| 2. Weight | Approx. 5,000 kg |
| 3. Structure: | <ul style="list-style-type: none"> • 1 CE Marked, structural steel plantroom fabricated in accordance with EN1090, Execution Class 2. • Fully Welded 230 x 90 Parallel flange channel heavy gauge U-channel steel base hot dip galvanised to BS EN1461.- TBC (see Structural Drawing Attached) • Checker plate aluminium steel floor. • Floor Drain Incorporated. • Certified Lifting points to main base frame for ease of lifting, 4 No. 3Ton lifting lugs. • 50x50 Mild steel box section main frame. • Half louvred Double door constructed of mild steel and finished with powder coat paint Goosewing Grey. • Mortise lock fitted to doors for security. • 2 No. 400x400mm louvered ventilation grilles to provide adequate fresh-air movement as required. • Gutters & Downpipes to be included. |
| 4. Exterior | <ul style="list-style-type: none"> • Wall Panel Kingspan Quadcore KS1000MM. • Trapezoidal Insulated Roof Panel - KS1000MR Kingspan Architectural Composite panel. • Panel thickness is 40mm to provide thermal transmittance of 0.46W/m2K. • Insulation core LPCB Certified to LPS 1181 grade EXT-B and FM approval to FMRC 4880 & 4471 Class 1 fire classification. • Standard external finish colour RAL 000 55 00. • Standard internal finish colour White. • Roof Panel KS1000RW Kingspan Architectural Composite panel. • Panel Thickness 40mm. • Standard colour goose-wing Grey. • Gutter to front of plant room. |
| 5. Internal Plant | <ul style="list-style-type: none"> • Roof/wall mounted extract fan w/ thermostat • Consumer Unit and MCC Panel |

ITEM:	Packaged Plantroom	ISSUE:	Tender	REV:	C01
REF DRG NO:	M-300	DATE:	May 2026	REF:	PP

Packaged Plantroom notional dimensions:



ITEM:	Packaged Plantroom	ISSUE: Tender	REV: C01
REF DRG NO:	M-300	DATE: May 2026	REF: PP

NOTES:

1. Packaged plantroom to be located at the back of the Academic Building to be manufactured and supplied by Hevac, Pakplant Ltd. or equivalent.
2. Packaged plantroom shall house all plant items associated with the mains water break tank installation and associated MCC controls as per the mechanical drawings.
3. This schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Water Booster Sets	ISSUE: Tender	REV: C01
REF DRG NO:	M-300 & M-301	DATE: May 2026	REF: P

<u>Ref. No.</u>	<u>Location</u>	<u>Duty (L/s)</u>	<u>Head (bar)</u>	<u>Model</u>	<u>Input Power (kW)</u>
P-0.01 A/B/C	Packaged Plantroom (Academic Building)	2.6	4.8	MEDANA CH3-LE.1603 1/E/3/10N/MOD	3.0
(Duty / Assist / Standby)					
P-0.02	Boiler House	5.2	4.8	SiBoost2.0 Smart 1 Helix VE 3602/5,5kW	5.5

(Duty Only) –pump rated at 100% of the duty flowrate)

NOTES:

- Water booster sets shall be as manufactured by Wilo Ltd. or equivalent.
- Each booster set shall be supplied and installed complete with volt free contacts for common alarm to suit BMS requirements and shall be mounted on a factory assembled stainless steel skid incorporating control panel and all necessary interconnecting stainless steel pipework.
- Booster pumpsets P-0.01 & 0.02 shall be a fully packaged water pressure pumpset prior to dispatch from the factory (no site assembly). The booster pumpsets shall be installed in accordance with DIN 1988 Parts 5 & 6 suitable for indirect mains water connection and shall have the following characteristics;
 - 1 No. or 3 No. vertical multistage centrifugal pumps driven by a 3Φ motor with integrated fluid-cooled frequency converter for variable speed control
 - Pump parts and impellers/diffusers in contact with the pumped liquid shall be stainless steel to EN DIN 1.4301
 - Pump bases and heads shall be stainless steel to EN DIN 1.4301.
 - Interconnecting pipework manifolds shall be stainless steel to EN DIN 1.4571
 - Base frame shall be stainless steel to EN DIN 1.4301
 - Each pump shall have 1 non-return valve and 2 isolating valves
 - Pressure gauge and pressure transmitter (analog output 4-20mA)
 - Diaphragm tank and isolating valve
 - On-board control package mounted in an IP54 rated steel cabinet, including main switch, all required fuses, motor protection, switching equipment and microprocessor controlled intelligent pump controller.

ITEM:	Water Booster Sets	ISSUE: Tender	REV: C01
REF DRG NO:	M-300 & M-301	DATE: May 2026	REF: P

4. Pump operation shall be controlled by the on-board control package which shall have the following components and functions;
 - Intelligent pump controller
 - Constant pressure control through continuously variable adjustment of the speed of each individual pump
 - PID controller with adjustable PI parameters
 - Constant pressure at setpoint, independent of inlet pressure
 - On/Off operation at low flow
 - Automatic cascade control of pumps for optimum efficiency
 - Selection of minimum time between start/stop, automatic pump changeover and pump priority
 - Automatic pump duty cycling with efficiency enhancing run-time control
 - Automatic pump test function to prevent idle pumps from seizing up
 - Digital inputs and outputs can be configured individually.
 - Volt-free contacts shall be provided for collective run and fault signals and for remote plant On/Off control.
5. The intelligent pump controller shall provide the following monitoring functions;
 - Min. and max limits of current value
 - Inlet pressure
 - Motor protection
 - Sensors and cable monitored against malfunction
 - Alarm log with the previous 24 alarms/warnings
6. All booster sets shall be suitable for an electrical supply of 400V / 3Ph / 50 Hz.
7. The Contractor shall supply and install a float switch and weight within each water storage tank for low suction level protection as supplied by the pump supplier.
8. Each booster set shall be factory tested and certified prior to dispatch from works.
9. This schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Pressurised Cold Water Tank	ISSUE: Tender	REV: C01
REF DRG NO:	M-300	DATE: May 2026	REF: PU

<u>Ref. No.</u>	<u>Location</u>	<u>Required Capacity (litres)</u>	<u>Qty</u>	<u>Size</u>
PU-0.01	Packaged Plantroom (Academic Building)	350	1	584(DN)x1656(H)

NOTES:

1. Cold water storage tanks shall be utility vertical type (slimline) pre-packaged water pressurisation units as manufactured and supplied by Multiboost or equivalent.
2. Tanks shall incorporate a low noise multi-impellor submersible pump suitable for use in applications with up to 40 start/stop cycles per hour. The pump shall be fitted with a continuous duty asynchronous motor and thermal overload protection.
3. Tanks shall be provided with a fixed-speed pressure controller to control the starting and stopping of the pump. The controller shall start the pump when the outlet pressure falls below 1.2 bar and stops when the flow stops.
4. Tanks shall be provided with built-in float valve, overflow and inspection hatch.
5. The tanks shall be provided with drip tray and shall come with insulation jacket installed on site by mechanical Contractor.
6. Tanks should be located so as to prevent water damage or consequential loss in the event of leakage howsoever occurring.
7. The dimensions of each water tank together with the tapping positions shall be approved prior to installation. Tanks to be fully cleaned & sterilised prior to installation & connection to the system
8. Tanks shall comply with BS7491 & BS EN 806, any other relevant standards & local authority requirements.
9. The schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Check Meters	ISSUE: Tender	REV: C01
REF DRG NO:	M-300	DATE: May 2026	REF: WM

<u>Ref. No.</u>	<u>Service</u>	<u>Location</u>	<u>Approx. Flowrate</u> (l/s)	<u>Line Size</u> (mm)	<u>Model</u>
WM-0.01	MWS from P-0.01 to Boiler House	Packaged Plantroom	5.2	54Ø	Woltmann H4000
WM-0.02	Incoming MWS to Mains Water Break Tank	Packaged Plantroom	5.2	54Ø	Woltmann H4000

NOTES:

1. Mains water flow meters shall be Woltmann series Multijet as manufactured by Elster Water Metering and supplied by or Active Energy Controls Ltd. or equivalent.
2. Mains water flow meters shall be WRAS approved and shall be suitable for a temperature range of 0 to 50°C.
3. Mains water flow meters shall be suitable for forward flow installations and shall be suitable for mounting in the vertical, horizontal or inclined position.
4. Mains water flow meters shall incorporate an integral strainer to protect the rotor and bearings.
5. Flow meters shall be wired M-Bus output type with interconnecting cable suitable for connection to the MCC panel as indicated on the schematic drawings. Pulse type meters will not be acceptable.
6. This schedule must be read in conjunction with the relevant part of the Specification.

ITEM:	Extract Fan	ISSUE: Tender	REV: EF
REF DRG NO:	M-300	DATE: May 2026	REF: WM

<u>Ref. No.</u>	<u>Location</u>	<u>Air Vol.</u> (l/s)	<u>ESP</u> (Pa)	<u>Type / Model</u>	<u>Input Power</u> (W)
EF-0.01	Packaged Plantroom	150	40	AW Wall/Roof Mounted Axial Fan - 200	53

NOTES:

1. Extract Fan shall be manufactured and supplied by Systemair Ltd or equivalent.
2. Extract Fan shall be manufactured in accordance with BS 848 and shall be built under the BS 9001 quality control procedures. All equipment and ancillary components must be selected from the same manufacturers range.
3. Extract Fan shall be IP rated for wall/roof installation
4. Extract fan shall be controlled via a wall mounted Temperature Sensor inside the packaged plantroom
5. Extract Fan shall be supplied with a VK-20 louvre shutter
6. Extract Fan shall be suitable for an electrical supply of 230V/1 Ph/50 Hz.
7. This schedule must be read in conjunction with the relevant part of the Specification.

APPENDIX 3

ELECTRICAL SUB-SYSTEM CERTIFICATION

In accordance with the Safety, Health & Welfare at Work (General Application) Regulations, 2007 – 2012 every new electrical installation and every major alteration or extension to an existing installation shall after completion be inspected and tested by a competent person in an approved manner, and a certificate of test shall be completed verifying that the relevant requirements of these Regulations have been complied with.

After the installation has been tested and found to comply, the contractor or other person responsible for the construction of the installation, or a person duly authorised to act on his behalf, must sign a statement to that effect. The statement must be in the form of an approved certificate. Certification in accordance with the requirements of I.S. 10101 will be deemed to meet this requirement. In addition to the certificate, the test record sheets containing the results of tests carried out must be retained. The certificate must be completed by an authorised person having adequate technical knowledge and experience.

In accordance with the above the proposed electrical installation specified herein shall be certified as having been installed, inspected and tested in full in accordance with I.S. 10101. In this respect ALL electrical works relating to the project shall be tested and certified.

Where a new or amended ESB service is required, the completed works shall be required to have an Safe Electric completion certificate.

For electrical sub-systems, which are defined as being “any system that will be connected to the low voltage network of any installation, with the exception of portable appliances that are designed for such use” and examples of which are:

- Lift installations
- Electrical works not requiring an ESB connection
- A/C or ventilation systems
- UPS
- Datacoms works
- Specialist electrical equipment installations
- Standby generation
- Fire protection systems
- Etc.

Such sub-system contractors shall ensure that:

- a All electrical works are carried out by a qualified electrician or by an apprentice electrician under the supervision of a qualified electrician.

- b A sub-systems certificate in the form attached must be completed by the sub-systems contractor for each sub-system within his contract, where applicable. This will include sub-system works carried out by another party, but forming part of the contractor's scope of work or contract. An example of this would be a fit-out electrical contractor who has a number of specialist systems suppliers, e.g. fire suppression, A/C, audio visual, under his fit-out contract but where he is linking to an existing main or sub main switchboard that has been installed and has had an Safe Electric completion certificate certified by others.
- c In addition to receiving one or more sub-systems certificates from the specialist suppliers working under his contract, the main sub-systems contractor must also complete a sub-systems certificate in respect of his work.
- d Prior to any electrical contractor making a power supply available to a sub-systems contractor, he must obtain a completed sub-systems certificate from that sub-systems contractor.

The contractor supplying a sub-systems certificate must be registered with a Safe Electric as either:

A registered Electrical Contractor

A registered Affiliate

A registered Associate

A Safe Electric or appropriate governing body completion certificate and sub-systems certificates, along with the test results associated with same, must be included in the Project Safety Manual.

APPENDIX 4

BSRIA TECHNICAL NOTE TN21/97 DEFINITIONS

1. DRAWINGS:

The following suggested definitions may be used to clarify the design responsibilities incumbent on those required to produce each drawing or document. These definitions are supported by drawn examples included in TN22/97 "The Allocation of Design Responsibilities Example Drawings".

1.1. SKETCH DRAWINGS

- 1.1.1. Line diagrams and layout indicating basic proposals, location of main items of plant, routes of main pipes, air ducts and cable runs in such details as to illustrate the incorporation of the engineering services within the project as a whole.

1.2. SCHEMATIC DRAWINGS

- 1.2.1. A line diagram describing the interconnection of components in a complex system. The main features of a schematic drawing should be as follows:
 - 1.2.1.1. The drawing may be a two dimensional layout with divisions to show the distribution of the system between building levels. It may also be an isometric style layout indicating the distribution of systems across individual floor levels. The drawing would not necessarily be constructed to scale.
 - 1.2.1.2. The drawing should include all functional components which make up the system i.e. plant items, pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.
 - 1.2.1.3. Symbols and line conventions should be in accordance with a recognised source of standard symbols, such as BS1199:Part3:1987 "Recommendations for symbols and other graphic conventions".
 - 1.2.1.4. The drawing should indicate components which have a sensing and control function and should indicate the links between them e.g. building management systems, fire alarms and HV controls.
 - 1.2.1.5. The drawing should be labelled with appropriate pipe, duct and cable sizes where these are not shown elsewhere.
 - 1.2.1.6. The major components indicated on the schematic drawing should be identified so that their whereabouts in specifications and on other drawings can be easily determined.

- 1.2.1.7. If required to form part of a **commissioning specification**, the drawing should include all data essential to testing and commissioning including volumetric flow rates, design total pressure losses at equipment, locations of dampers, valves and flow measuring stations, electrical faults, levels, current ratings, short circuits capacities and tripping times.

NB: Where a design consultant is appointed to produce a scheme design for completion by a design and build contractor, only the first three of these requirements are likely to be appropriate.

1.3. DETAILED DESIGN DRAWINGS

- 1.3.1. A drawing showing the intended locations of plant items and service routes in such detail as to indicate the design intent. The main features of detailed design drawings should be as follows:
- 1.3.1.1. Plan layouts should be to a scale of at least 1:100. Plant areas should be to a scale of 1:50, and should be accompanied by cross sections.
 - 1.3.1.2. The drawing will not include the precise position of services, but it should nevertheless be feasible to install the services within the general routes indicated. It should be possible to produce **co-ordination drawings** or **installation drawings** without major re-routing of the services.
 - 1.3.1.3. Pipework should be represented by single line layouts, Ductwork should be represented by either double line or single line layouts as required to ensure that the routes indicated are feasible. Symbols and line conventions should be in accordance with a recognised source of standard symbols such as BS1192:Part3:1987 'Recommendations for symbols and other graphic conventions'.
 - 1.3.1.4. The drawing should indicate the space available for major service routing in both horizontal and vertical planes.

1.4. CO-ORDINATION DRAWINGS

- 1.4.1. A drawing showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of a co-ordination drawing should be as follows:
- 1.4.1.1. Plan layouts should be to a scale of at least 1:50 and accompanied by cross sections to a scale of at least 1:20 for all congested areas.
 - 1.4.1.2. The drawing should be spatially co-ordinated i.e. there should be no physical clashes between the system components when installed at the scaled-off positions shown on the drawing. In areas where tolerances are minimal, dimensions should be provided.
 - 1.4.1.3. The spaces between pipe and duct runs shown on the drawing should make allowances for the service at its widest point.

Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.

- 1.4.1.4. The drawing should be make allowance for those plant items specified by the designer and identified in the design specification.
- 1.4.1.5. The drawing should make allowances for installation working space and space to facilitate commissioning and maintenance.
- 1.4.1.6. The drawing should indicate positions of main fixing points and supports where they have significance to the structural design.
- 1.4.1.7. The services should be arranged in such a way that it is possible to demonstrate a feasible sequence of installation.
- 1.4.1.8. The drawing should be supported by “individual services drawings” where these are desirable for clarity.
- 1.4.1.9. Plant room layouts should be to a scale of at least 1:20 and be accompanied by cross sections and elevations to a scale of at least 1:20.

1.5. INSTALLATION DRAWINGS

- 1.5.1. A drawing based on the **detailed design drawing** or **co-ordination drawing** with the primary purpose of defining that information needed by the tradesmen on site to install the works

NB Where co-ordination drawings have not been prepared in advance, responsibility for spatial co-ordination should be allocated to the “lead” installing contractor who should be named in the tender documents. All installation requirements should then be produced taking into account the needs of co-ordination.

- 1.5.2. Main features of installation drawings should be as follows:

- 1.5.2.1. Plan layouts should be to a scale of at least 1:50 and should be accompanied by cross sections to a scale of at least 1:20 for all congested areas.
- 1.5.2.2. The drawing should be spatially co-ordinated, i.e. there should be no physical clashes between the system components when installed at the scaled-off positions shown on the drawing.
- 1.5.2.3. Allowances should be made for inclusion of all supports and fixings necessary to install the works.
- 1.5.2.4. The spaces between pipe and duct runs shown on the drawing should make allowance for the services at its widest point. Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.
- 1.5.2.5. The drawing should make allowances for installation details provided from *shop drawings*.

- 1.5.2.6. The drawing should make allowances for installation working spaces, space to facilitate commissioning and space to allow on-going operation and maintenance in accordance with the relevant health and safety requirements.
 - 1.5.2.7. Allowances should be made for plant and equipment including those which are chosen as alternatives to the designer's specified option.
 - 1.5.2.8. Dimensions should be provided where the positioning of the services is considered to be important enough not to leave to the tradesmen on site.
 - 1.5.2.9. Plant room layouts should be to a scale at least 1:20 and be accompanied by cross sections and elevations to a scale of at least 1:20.
- 1.6. INSTALLATION WIRING DIAGRAM
- 1.6.1. Drawing showing the interconnection of electric components, panels etc. in accordance with the design intent indicated on the **schematic drawings** and incorporating the details provided on **manufacturer's certified drawings**.
- 1.7. SHOP DRAWINGS
- 1.7.1. Drawing prepared by a fabricator or supplier for a particular project, and which is unique to that project. examples include supplier's drawings for ductwork, pre-fabricated pipework, sprinkler systems, control and switchgear panels and associated internal wiring.
- 1.8. MANUFACTURER'S DRAWING
- 1.8.1. Drawing provided by a manufacturer or supplier to indicate a typical representation of the product, components or plant items to be supplied for a particular project.
- 1.9. MANUFACTURER'S CERTIFIED DRAWING
- 1.9.1. Drawing provided by a manufacturer or supplied to indicate details of the product, components or plant items and which the manufacturer or supplier guarantees the supplied equipment will comply with.
- 1.10. RECORD DRAWING
- 1.10.1. Drawing showing the building and services installations as installed at the date of practical completion. The main features of the record drawings should be as follows:

1.10.2. The drawings should provide a record of the locations of all the systems and components installed including pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.

1.10.2.1. The drawings should be to a scale not less than that of the installation drawings.

1.10.2.2. The drawings should have marked on them positions of access points for operating and maintenance purposes.

1.10.2.3. The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.

1.11. BUILDER'S WORK DRAWING

1.11.1. Design State Definition:

1.11.1.1. A drawing to show the provisions required to accommodate the services which significantly affect the design of the building structure, fabric and external works. Most drawings (and schedules) of work to be carried out by building trade, and require to be costed at the design stage e.g. plant bases.

1.11.2. Installation stage definition:

1.11.2.1. Drawing to show requirements for building works necessary to facilitate the installation of the engineering services (other than where it is appropriate to mark out on site).

1.12. SPECIALIST DRAWING

1.12.1. A generic term for those drawings which may be supplied by a specialist supplier or sub-contractor appointed to undertake design duties in relation to a specific aspect of the project.

1.13. TENDER DRAWING

1.13.1. Drawing produced for the purpose of obtaining competitive tenders. The tender drawings will comprise an agreed set of drawings to suit the complexity of the project, and which comply with the specific drawing definitions included in this section.