JV TIERNEY & CO
MECHANICAL ELECTRICAL & SUSTAINABLE ENGINEERS



Mechanical Services Specification

TIPPERARY COURTHOUSE & BRIDEWELL
RE-DEVELOPMENT PROJECT
CCT-JVT-XX-XX-XX-SP-M-0001

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TIPPERARY COURTHOUSE & BRIDEWELL RE-DEVELOPMENT PROJECT MECHANICAL SERVICES SPECIFICATION

MECHANICAL SERVICES TENDER DOCUMENTS	
CCT-JVT-XX-XX-XX-SP-M-0001	**Mechanical Services Specification**
CCT-JVT-XX-XX-XX-SH-M-0001	Mechanical Services Schedules
CCT-JVT-XX-XX-XX-ST-M-0001	Mechanical Services Summary of Tender

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JVT 1948-2023 CELEBRATING 75 YEARS

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Contents

1 GENERAL 1-8
1.1 GENERAL REQUIREMENTS 1-8
1.2 INTRODUCTION AND INTERPRETATION 1-8
1.3 DEFINITIONS 1-9
1.4 UNIT ABBREVIATIONS 1-10
1.5 GENERAL CODES & STANDARDS APPLICABLE 1-11
1.6 TENDER CLARIFCATIONS 1-11
1.7 TENDER SUBMISSION 1-11
1.8 OMISSIONS MADE POST TENDER SUBMISSION 1-12
1.9 SCOPE OF CONTRACT 1-12
1.10 TAX CLEARANCE 1-12
1.11 MAINTAINABILITY 1-13
1.12 TECHNICAL SUBMITTALS 1-13
1.13 FREEDOM OF INFORMATION ACT 2014 1-14
1.14 COMPLIANCE WITH EC DIRECTIVES AND REGULATIONS 1-14
1.15 TENDER DRAWINGS 1-14
1.16 BUILDERS WORK/DRAWINGS 1-15
1.17 CO-ORDINATION OF SERVICES 1-15
1.18 FIRE PROTECTION 1-15
1.19 INSTALLATION GUIDELINES & QUALITY CONTROL 1-16
1.20 CLIENT DEMONSTRATIONS 1-16
1.21 PROPREITARY PRODUCT OR MANUFACTURER'S NAME 1-17
1.22 PRACTICAL COMPLETION CERTIFICATE 1-18
1.23 DEFECTS LIABILITY 1-18
1.24 INSURANCES 1-18
1.25 GUARANTEE BOND 1-18
1.26 SITE CLEANLINESS 1-19
1.27 BUILDING CONTROL (AMENDMENT) REGS 2014 1-19
2 GENERAL CONDITIONS OF CONTRACT 2-20
2.1 PROJECT PARTICULARS 2-20
2.2 BASIS OF CONTRACT 2-20
2.3 EXAMINATION OF SITE 2-20
2.4 LIMITATIONS ON WORKING HOURS AND WORKING SPACE 2-21
2.5 PROGRAMME FOR COMPLETION OF WORKS 2-21
2.6 PROJECT DESCIPTION 2-22
2.7 COMMISSIONING 2-23

2.8 BUILDING CONTROL (AMMENDMENT) REGS 2014 2-23
COMMENCEMENT STAGE 2-24
DURING CONSTRUCTION 2-24
UPON COMPLETION 2-24
PHOTOGRAPHIC EVIDENCE 2-24
2.9 METERING 2-25
3 PIPEWORK INSTALLATION 3-26
3.1 STANDARDS 3-26
3.2 PIPEWORK ABBREVIATIONS 3-26
3.3 PIPEWORK GENERAL 3-26
3.4 WALL AND FLOOR SLEEVES 3-27
3.5 WALL, FLOOR AND CEILING PLATES 3-27
3.6 PIPE SUPPORTS 3-27
3.7 CONTROL VALVES 3-28
3.8 COMMISSIONING SETS 3-29
3.9 CLEANING FOR PAINTING 3-29
3.10 RUN OF PIPING 3-29
3.11 CONNECTION TO FIXTURES 3-29
3.12 LPHW PIPING 3-31
3.13 EXTERNAL HEATING & WATER PIPEWORK 3-31
3.14 MULTI-LAYER PIPING 3-32
3.15 REFRIGERANT PIPING 3-33
3.16 COPPER PIPING 3-35
3.17 PLANT ROOM PIPEWORK 3-36
3.18 IDENTIFICATION COLOURS FOR PIPING 3-37
4 THERMAL INSULATION 4-39
4.1 GENERAL 4-39
4.2 FIRE SAFETY 4-39
4.3 EXCLUDED MATERIALS 4-39
4.4 SERVICES TO BE INSULATED 4-41
4.5 INSULATION MATERIALS 4-42
4.6 PROTECTIVE FINISHES 4-43
4.7 PARTICULAR ITEMS 4-44
4.8 TABLE OF MATERIALS 4-47
4.9 INSULATION THICKNESS 4-49
4.10 PIPING/DUCTING INSULATION AND THICKNESS 4-49
5 PLANT ROOM INSTALLATION (ELEMENT 51) 5-52
5.1 PROPRIETARY AIR TO WATER HEAT PUMPS 5-52
5.2 LPHW FILLER/PRESSURISATION UNITS 5-53
5.3 EXPANSION VESSELS (LTHW) 5-54

5.4 THERMOMETERS 5-54
5.5 VALVE CHARTS 5-54
5.6 PRESSURISATION UNIT(S) 5-55
5.7 CIRCULATING PUMPS 5-56
5.8 MOTORISED CONTROL VALVES 5-63
5.9 CONTROL VALVES 5-63
5.10 DE-AERATOR AND DIRT SEPERATOR 5-63
5.11 DISCONNECTION OF PIPES 5-63
5.12 THERMOMETERS 5-63
5.13 DRAIN COCKS 5-63
5.14 AUTOMATIC CONTROLS 5-64
5.15 SUPERVISORY SERVICE AND COMMISIONING OF CONTROLS 5-64
5.16 PLANT ROOM CONTROL PANEL 5-64
5.17 PAINTING 5-65
5.18 ELECTRIC WIRING 5-65
5.19 BALANCING OF CIRCUITS 5-65
5.20 TEST 5-65
5.21 HANDOVER AND DEMONSTRATION 5-65
6 SOILS AND WASTES – ABOVE GROUND (ELEMENT 52) 6-66
6.2 PIPEWORK (WCs-SOIL) 6-66
6.3 JOINTING 6-68
6.4 EXPANSION 6-68
6.5 SUPPORTS 6-68
6.6 WASTE TRAPS 6-69
6.7 CLEANING EYES 6-69
6.8 RODDING EYES 6-69
6.9 VENTS AND COWLS 6-69
6.10 SANITARY FIXTURES 6-69
6.11 TRAPS 6-69
6.12 TESTING 6-70
6.13 INTUMESCENT COLLARS 6-70
6.14 CO-ORDINATION 6-70
6.15 FLOOR GULLIES 6-70
7 HOT, COLD, MAINS WATER INSTALLATION (ELEMENT 53) 7-71
7.2 ELECTRIC WATER HEATERS 7-71
7.3 THERMOSTATIC MIXING VALVES 7-71
7.4 DOMESTIC WATER SYSTEMS 7-72
7.5 POTABLE ‘DRINKING’ WATER SUPPLY 7-72
7.6 PORTABLE EXTINGUISHERS 7-72
7.7 STERILISATION OF THE COMPLETED INSTALLATION 7-73

7.8 TESTS 7-73
8 MECHANICAL COOLING INSTALLATION (INCL. ELEMENT 57) ..... **Error! Bookmark not defined.**
8.1 EXTENT OF WORKS ..... **Error! Bookmark not defined.**
8.2 HEAT PUMP SPLIT SYSTEM ..... **Error! Bookmark not defined.**
8.3 SUPERVISORY SERVICE FOR HEAT PUMP SYSTEM ..... **Error! Bookmark not defined.**
8.4 REFRIGERANT SYSTEM ..... **Error! Bookmark not defined.**
8.5 PIPEWORK AND FITINGS ..... **Error! Bookmark not defined.**
8.6 PIPEWORK INSTALLATION ..... **Error! Bookmark not defined.**
8.7 COMPRESSORS ..... **Error! Bookmark not defined.**
8.8 CONDENSORS ..... **Error! Bookmark not defined.**
8.9 ANCILLARY ITEMS ..... **Error! Bookmark not defined.**
8.10 PRESSURE TESTING ..... **Error! Bookmark not defined.**
9 HEATING INSTALLATION (ELEMENT 56) 8-75
9.1 ELECTRIC RADIATORS 8-75
9.2 LOW SURFACE TEMPERATURE (LST) EMITTERS 8-75
9.3 UNDERFLOOR HEATING 8-77
9.4 RADIATOR VALVES 8-78
9.5 AIR VALVES FOR RADIATORS. 8-79
9.6 EXPANSION DEVICES 8-79
9.7 THERMOSTATIC CONTROL VALVES 8-80
9.8 TESTS 8-80
10 VENTILATION INSTALLATION (ELEMENT 57) 9-81
10.1 EXTENT OF WORKS 9-81
10.2 DUCTWORK 9-81
10.3 HANGERS AND SUPPORTS 9-83
10.4 ACCESS OPENINGS 9-84
10.5 TEST HOLES 9-84
10.6 CONNECTIONS TO BUILDER'S WORK 9-84
10.7 PROTECTIVE FINISHES 9-84
10.8 DAMPERS 9-84
10.9 SUPPLY/EXTRACT GRILLES AND DIFFUSERS 9-87
10.10 FANS 9-87
10.11 LOUVRES 9-90
10.12 TESTING AND COMMISSIONING 9-90
11 AUTOMATIC CONTROLS (ELEMENT 59) 10-95
11.1 SCOPE 10-95
11.2 BUILDING MANAGEMENT SYSTEM 10-95
11.3 CONTROL DEVICES 10-103
11.4 CONTROL VALVES 10-105
11.5 MOTOR CONTROL AND STARTER PANELS 10-106

11.6 MECHANICAL CONTROL PANELS 10-110
11.7 TESTING AND COMMISSIONING 10-111
11.8 RECORD DOCUMENTATION 10-112
12 INSPECTION TESTING AND COMMISSIONING 11-114
12.1 GENERAL 11-114
12.2 INSPECTION 11-115
12.3 NON-DESTRUCTIVE TESTING 11-116
12.4 PRESSURE TESTING 11-117
12.5 COMMISSIONING 11-118
12.6 PERFORMANCE TESTING 11-118
12.7 DEMONSTRATION AND HAND-OVER 11-119
12.8 COMPLIANCE WITH BUILDING REGULATIONS 11-119
12.9 MAINTENANCE AND EQUIPMENT 11-119
13 HEALTH, SAFETY & WELFARE AT WORK (CONSTRUCTIONS) REGS 2013 12-120
13.1 PROJECT SUPERVISORS 12-120
13.2 CO-ORDINATION OF PERSONS ENGAGED IN THE DESIGN OF THE PROJECT 12-120
13.3 DUTIES OF NOMINATED SUB-CONTRACTORS AS DESIGNERS 12-120
13.4 GENERAL DUTIES AS DESIGNERS 12-121
13.5 MECHANICAL CONTRACTOR TO CHECK ALL MATTERS 12-121
14 EQUIPMENT SUBMISSION PROCEDURE 13-122
14.1 INTRODUCTION 13-122

1 GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1 The services contractor shall obtain a copy of the Main Contract Preliminary Clauses and include all costs necessary associated with the Main Contract Preliminary Clauses within their tender submission. – No further monies shall be forthcoming for any errors or omissions due to the failure of the contractor to not have included for any costs associated with their clauses.

1.2 INTRODUCTION AND INTERPRETATION

1.2.1 The Services Contractor shall supply, install, test and commission the installations as detailed on the Tender drawings and within this specification, employing skilled personnel and specialist contractors as necessary to achieve the standards described.

1.2.2 If conflict of information occurs between any Contract Documents then the onus shall be with the Contractor to confer and clarify the conflicts during the tendering process.

1.2.3 Where an item is included in the Specification but not shown on the Drawings, it shall be included in the Works and deemed to be included in the Contract Price.

1.2.4 Where an item is shown on the Drawings but not included in the Specification, it shall be included in the Works and deemed to be included in the Contract Price.

1.2.5 The Architectural Room Layouts (Room Data Sheets) shall be available to the contractor for setting out of services within Specialist Rooms. It shall be noted that the onus shall be on the Mechanical Contractor to review all Architectural Room Layouts and Mechanical and Electrical Services Layout drawings, Schematics and Specifications, and highlight in a timely manner, any items where clarification is required. In all cases, the Mechanical and Electrical Specifications and Drawings shall take precedence with regards to quantities of equipment, outlets etc. The Architectural Room Layouts (Room Data Sheets) shall take precedence in relation to setting out of services. (It should be noted that mechanical and electrical outlets that are shown on the services drawings, located in ceiling voids, shall not appear on Architectural Room Layouts).

1.2.6 All queries relating to room layouts and setting out dimensions must be issued to the Project Architect at least 6 weeks in advance of the proposed installation date.

1.3 DEFINITIONS

1.3.1 **Contractor** – Where this term is used within the specification it shall be taken as the Design and Build Team.

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

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

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

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

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

1.3.7 **Engineer** – Refers to a representative of J.V Tierney & Co.

1.3.8 Unless the clauses in this Specification stipulate “supply only” or “installation only” the words
“Supply”, “Provide” or “Install”, shall mean “supply and installation”.

1.3.9 **Manufacturer’s Recommendations -** shall mean the handling, storage, preparation, installation testing and commissioning of products in accordance with manufacturers printed or written recommendations/ instructions. The contractor shall inform the engineer if these instructions conflict with any other specified requirement.

1.4 UNIT ABBREVIATIONS

mm	Meter	Hz	Hertz
m^2	Square Meter	NR	Noise Rating Curves
m^3	Cubic Meter	l/s	Litres Per Second
N	Newton	W	Watts
kg	Number	^oC	Degrees Centigrade

1.5 GENERAL CODES & STANDARDS APPLICABLE

CODES & STANDARDS	
Current Building Regulations	American Society of Heating Refrigeration and Air Conditioning Engineers (A.S.H.R.A.E.).
Chartered Institute of Building Services Engineers (C.I.B.S.E) Guides.	Relevant EN, IS and BS Codes and standards.
Asbestos at Work Regulations and Amendments National Joint Utilities Group Publications	Health Technical Memoranda as published by the UK's Department of Health.
Air Quality Standards Regulations 2011.	Heating and Ventilation Contractors Association (HVAC)
ETCI 101:2008 National Rules of Electrical Installations.	Health and Safety at work Act Current IEE Wiring Regulations (BS7671)
Air Pollution Acts 1987 and 2011	Gas Safety Regulations & Liquid Petroleum Regulations
COSHH Regulations Electricity at work Regulations	HSA Regulations Electricity at work Regulations
ErP (Energy related products)/EuP (Energy using Products) Directive 2018 efficiency requirements.	All equipment shall conform with the specification of the SEAI Triple E register performance criteria as a minimum.

1.5.1 Any Standard, Guide, Technical Memorandum, Application Manual, Code, Handbook, Publication, European Directive, National Rule, Statutory Requirement referenced in this Specification document for compliance purposes shall be deemed to be the latest version of the document including any associated annexes, amendments, addenda & corrigenda published on or before the issue date of this specification document.

1.5.2 The standards listed shall not be regarded as an exhaustive list.

1.5.3 All standards referred to within the specification shall apply where relevant.

1.5.4 Where contractor or their specialists feel there is a conflict between the specified standards and or the requirements of the specification, they shall notify the engineers in writing and seek clarification on the matter.

1.6 TENDER CLARIFCATIONS

1.6.1 If the Contractor tendering for this project is in any doubt as to the intent detailed within the Works Requirements and the scope of works involved in the successful project completion they shall submit clarifications in the appropriate manner within the timeframes outlined in the contract. If no clarifications are sought during this process then it is deemed the Contractor is fully aware of the works involved in completing the project.

1.7 TENDER SUBMISSION

1.7.1 The tender submission shall comprise the following documents in a sealed envelope, labelled as explained in the covering tender e-mail/letter.

- Covering Letter.
- Site Specific Methodology and programme for the works.
- Portfolio of Previous Experience on Similar Projects.
- Proposed Project Management Team.
- CV of proposed contracts manager.
- Schedule of rates.

1.7.2 If the contractor fails to present any of the information listed above it will mandatorily invalidate their tender.

1.8 OMISSIONS MADE POST TENDER SUBMISSION

1.8.1 No compensation for loss of profit or otherwise shall be allowed to the Contractor for omissions made to the Contract after Tenders are received. The Client reserves the right to omit any portion of the work and any claim for loss of profits due to such omissions shall not be entertained.

1.9 SCOPE OF CONTRACT

1.9.1 The Contractor is to provide all materials and labour necessary except any as are specially excluded by the specification for the proposed mechanical services installation.

1.9.2 The contract price shall cover the supply, delivery, erection, testing and maintenance of the installation as outlined hereafter and as shown on the drawings which shall be taken as forming part of the specification.

1.9.3 The Contractor shall include all labour, materials, import charges and transport which may be required for and in the construction of the works detailed in the specification and drawings and for the use of all necessary scaffolding, ladders, plant, tackles, machinery, tools and other appliances for the workmen together with the carriage thereof to the spot where they are required to be used and their subsequent removal

1.10 TAX CLEARANCE

1.10.1 It is a condition of a contract award that the successful tenderer shall, for the term of such contract, comply with all EU and domestic tax laws. Prior to the award of a contract, the successful tenderer is required to provide their Tax Clearance Certificate in addition to providing its Tax Clearance Access Number and Tax Reference Number to facilitate online verification of its tax status by the contracting authority. By supplying these numbers the successful tenderer acknowledges and agrees that the contracting authority has the permission of the successful tenderer to verify its tax cleared position online. Failure to provide evidence of tax cleared status will mandatorily invalidate the tender.

1.11 MAINTAINABILITY

1.11.1 The Mechanical Contractor shall demonstrate that all plant and equipment incorporated into the works can be safely accessed and maintained in compliance with Health and Safety legislation and can also be safely removed for replacement. All new installations shall comply with HTM 2023, NSAI and DMG 08 M&E Spatial Requirements (Defence Works Functional Standard). All plant shall be installed in compliance with the maintenance requirements as set out in CIBSE Guide M 2008.

1.12 TECHNICAL SUBMITTALS

1.12.1 The contractor must provide technical submissions for all systems and equipment that is proposed for comment (status A, B, C) by the Engineer. These shall be presented a minimum of eight weeks in advance of the respective equipment, services being required for services co-ordination purposes.

1.12.2 These submissions shall cover all aspects of the works. Details of Specialist installations should be included in the tender submission documents. The purpose of the submissions is to allow the contractor to demonstrate compliance with the Works Requirements.

1.12.3 A review of the submissions by the Engineer does not constitute any approval of the systems and equipment being proposed. It is the responsibility of the Contractor to comply in full with the Works Requirements and whether submissions are reviewed, or not, or commented on, or not, does not relieve the Contractor of their responsibility to comply with the Works Requirements. Where items or installations are subsequently found at any stage to be not in compliance with the Works Requirements, the Contractor shall rectify the works at their own expense.

1.12.4 In addition to the above, the submissions shall be provided in a timely manner to suit the programme of works. A maximum of two Technical Submissions shall be presented in any one working week to allow review by the Engineer. The contractor is required to submit a programme in their Tender Submission of when each technical submittal shall be presented for review by the Engineers. The Engineers shall endeavour to comment on each technical submission within 10 working days of receipt of the submissions; however failure to present this programme in the tender submission or to adhere to the programme may result in delays in any comments presented by the Engineers. The Engineers shall not be held responsible for any delays in the contractor's works due to late receipt of technical submissions for review.

1.13 FREEDOM OF INFORMATION ACT 2014

1.13.1 Please note also that from 14th October 2014 the Freedom of Information Act 2014 came into force and the previous Act, the Freedom of Information Act 1997 and the Freedom of Information (Amendment) Act 2003 where repealed. As a result of the Freedom of Information Act, public bodies cannot give guarantees of confidentiality which have previously featured in public procurement.

1.13.2 Information in relation to this tender may be made available on demand in accordance with Freedom of Information Act 2014.

1.13.3 You are asked to consider if any of the information supplied by you in this (tender) should not be disclosed because of its sensitivity. If this is the case, you should, when providing information, identify same and specify the reasons for its sensitivity. The Contracting Authority will consult with you about sensitive information before making a decision on any Freedom of Information request received.

1.13.4 If you consider none of the information supplied by you is sensitive, please make a statement to that effect. Such information may be released in response to a Freedom of Information request.

1.14 COMPLIANCE WITH EC DIRECTIVES AND REGULATIONS

1.14.1 The Contractor shall ensure that all equipment supplied on the project shall comply with the Machinery Directive (89/392/EEC), the Low Voltage Directive (73/23/EEC), the Electro Magnetic Compatibility Directive (889/336/EEC) and all other Directives as outlined in the National Standards Authority of Ireland's Information Sheet entitled "New Approach Directives & CE Marking".

1.14.2 Where required under these Directives, all machinery and equipment installed by the Contractor shall carry the CE Marking which shall comply in every detail with the EC Directives as outlined above.

1.14.3 Equipment supplied to site not carrying the relevant CE Marking shall be removed by the Contractor and replaced with properly marked equipment, at no additional cost to the Client.

1.14.4 The contractor shall be responsible for the removal and disposal of all the obsolete electrical equipment in accordance with the current WEEE (Waste Electrical and Electronic Equipment) directive 200296/EC.

1.14.5 The contractor is deemed to be familiar with these regulations and shall include for full compliance within their tender submission.

1.15 TENDER DRAWINGS

1.15.1 The Tender drawings issued are provided to show primary routes, design intent, component order etc. They shall not be used as working or fabrication drawings. The Contractor shall develop the exemplar drawings in order to provide a complete set of working and fabrication drawings for the installation works. The drawings and installed systems shall:

- Include all fittings etc. in order to comply with this specification.

- Be based upon measured site dimensions.
- Include minimum spacing as specified.
- Be fully co-ordinated as detailed elsewhere in this specification.

1.16 BUILDERS WORK/DRAWINGS

1.16.1 All builders work, cutting of opes, etc. shall be carried out by the Main Contractor. The Services Contractor(s) shall, however, be cognisant when planning of services runs, etc. to keep the amount of cutting away and making good to a minimum and shall exercise extreme care to avoid damage to the building and its contents during the course of the contract.

1.16.2 The Contractor shall also be responsible for producing accurate builder's work drawings for all services. These shall be handed over to the Builder within four weeks of commencement of contract, together with a copy to the Engineers.

1.16.3 The Contractor shall note that all the services installations have been designed in a coordinated fashion, in conjunction with the Structural Engineer and Professional Team (Design Team). Any proposed alterations to the services installations as designed, shall be at the risk of the contractor. All professional fees associated with re-design of proposed services installations (following proposed design changes from the contractor) and/or review of proposed design changes including proposed alternative structural openings for services shall be charged to the contractor.

1.17 CO-ORDINATION OF SERVICES

1.17.1 The Mechanical and Electrical Contractors shall jointly produce fully co-ordinated working drawings for the entire installation. These drawings shall be produced on a phased basis to co-ordinate with the builders programme. The Mechanical Contractor shall act as lead co-ordinator in the co-ordination process and in the production of the finalised co-ordination drawings. The coordination process shall also include the coordination of the complete Mechanical and Electrical services installation. The lead co-ordinator shall be responsible for setting up and conducting co-ordination meetings to co-ordinate the electrical, mechanical and builder's services. The co-ordinated drawings shall include detailed plan layouts and detail cross sectional drawings of all services including invert levels of all services. Separate co-ordinated drawings will be produced for each floor of each of the individual buildings in the project.

1.17.2 The drawings shall be issued to the Architects and the Consulting Engineers for approval prior to commencement of work in any section of the installation.

1.17.3 The Mechanical Contractor shall be responsible for issuing co-ordinated mechanical and electrical drawings to the design team and main contractor.

1.17.4 The Mechanical Contractor shall employ full time on site person as a competent M&E services co-ordinator.

1.18 FIRE PROTECTION

1.18.1 During the course of the contract, the Contractor shall ensure that the proper fire precautions are taken, and their operatives shall be provided with a fire blanket and extinguisher at all stages of the works.

1.19 INSTALLATION GUIDELINES & QUALITY CONTROL

1.19.1 The Mechanical Contractor must provide installation guidelines and as built documentation for all equipment to be installed, on an on-going basis throughout the duration of the contract. It will not be accepted for installation guidelines to be produced only at the end of construction.

1.19.2 The Mechanical Contractor is responsible for carrying out internal quality control checks, ensuring all systems and equipment are installed in line with the manufactures requirements prior to inspections on site by Design Team / Clerk of Works.

1.20 CLIENT DEMONSTRATIONS

1.20.1 The Contractor shall allow in their tender for demonstrating the operations of the entire Services Installation of plant and systems included within this document to the client facilities team, Maintenance Department and Clerk of Works subject to one being appointed.

1.20.2 These demonstrations shall be video recorded onto DVD together with a typed out and bound systems operation maintenance document and handed over to the Engineers for approval. The demonstrations will take place on a daily basis only after the system is fully commissioned.

1.20.3 The contractor shall allow 2 man weeks of Controls, Site Technician's time for comprehensive hand-over demonstrations to the Engineer and the Building Manager (separately).

1.21 PROPREITARY PRODUCT OR MANUFACTURER'S NAME

1.21.1 Where a Proprietary Product name or Manufacturer's name is listed and or referenced within this specification, the words "or equivalent" will be deemed to be included and it will serve as a benchmark for quality & standard for that product. Hence, an equivalent manufacturer's product (i.e. meeting the specification in all respects) is acceptable (without prior approval) and that the onus is on the Contractor to ensure that the product meets the standard required. Such output requirements might include a requirement for a test or Agreement Certificate or Insurance backed guarantee or other means of proof of compliance to the Engineer's satisfaction. The contractor shall also be aware that naming a specific product is not prohibited as part of implementing the European Union (Award of Public Authority Contracts) Regulations 2016 and EU Directive 2014/24/EU and SI No.329/2006 Communities (Award of Public Authorities Contracts) 2006, where 'justified' by the subject matter of the contract.

1.21.2 In these specifications trade names and or suppliers are occasionally used for the purpose of brevity and clarity of technical, aesthetic and functional intent.

1.21.3 Such references are for the convenience of the tenderer in clearly indicating the standard of technical, aesthetic and functional requirements sought by the specifier. The intention is not to favour one product over another or to eliminate other products/suppliers from consideration.

1.21.4 Other materials/suppliers may be put forward for consideration as equivalent materials/suppliers to those stated in the specification.

1.21.5 Comments on substitution of equivalent materials/suppliers will be given where the alternative material/supplier are demonstrable equal in full accord with the specification.

1.21.6 Equivalence of an offered substitution will be judged on the basis of objective, clear and independent proof of compliance with equal standards to those specified.

1.21.7 Where appropriate verification is provided through a detailed technical dossier, drawings, data sheets and/or a test report from a recognised body, a material/product substitution will be permitted by the Architect/Engineer who is the client representative. Any increased costs arising whatsoever from such a substitution in terms of redesign, rescheduling, health and safety issues, etc., shall be borne by the contractor.

1.21.8 The evaluation of substitute materials/products will include assessment of their environmental characteristics.

1.21.9 Alternative suppliers/installers will need to prove their ability to perform their sub-element part of the main contract through the submission of proof of their technical and/or professional capacity (education, experience, equipment, etc.); including their ability to manage in an environmentally sound manner such as OHAS or other certified environmental management systems or details of such measures taken in previous contracts.

1.21.10 The contracting authority through its Architect/Engineer, who is the client representative, will evaluate on a case-by-case basis, from a technical, aesthetic, and functional perspective, what constitutes an equivalent standard and or product. Evaluation will take place only after the award of contract, as part of the contract management regime.

1.21.11 Where the specified product satisfies the criteria for enhanced capital allowances and hence is published within the energy technology product list, the alternative product must do likewise.

1.22 PRACTICAL COMPLETION CERTIFICATE

1.22.1 A Certificate of Practical Completion shall be issued by the Engineer following completion of the following works:

- Handover and Demonstration of Systems / Installations to the client.
- Handover of O&M manuals and safety file to the client

1.23 DEFECTS LIABILITY

1.23.1 The defects liability period shall be 12 months from date of certified Practical Completion as described above.

1.23.2 Any defects developing in the system during the Defects Liability period shall be rectified and made good at the Contractor's own expense.

1.23.3 The contractor shall be responsible for rectifying, any faults which occur in the installation resulting from faulty workmanship or material or failure of the Contractor to observe the requirements of this Specification, or the instruction of the manufacturer or the Engineer.

1.23.4 In the event of the Contractor refusing to rectify defects within a reasonable period, the Engineers will have the work done by others and any charges arising shall be at the expense of the Contractor.

1.24 INSURANCES

1.24.1 The Contractor shall include for all necessary insurances, including Employers Liability, Public Liability, Third Party, Workman’s Compensation, and Contractors All Risks, and all other statutory requirements applicable. Refer to the main contract preliminaries for minimum insurance levels required.

1.25 GUARANTEE BOND

1.25.1 The Contractor shall be requested to obtain a Guarantee Bond to cover 10% of the value of the Contract work. The Contractor shall enter into a Bond with an approved Insurance Company. The Contractor shall include in the summary of tender the cost of obtaining such Bond.

1.26 SITE CLEANLINESS

1.26.1 The Services Contractor shall allow for cleaning up and carting away all their own rubbish as it accumulates during the progress of the works, including that of their Sub-Contractors, and on completion they is to clear up and cart away all superfluous materials, clean down external faces of buildings affected by the works, scrub pavings and floors, clean out gullies and gutters etc., clean glass inside and out, remove all spots, splashes and stains and leave the works and all parts of the premises affected by them clean and in good order to the entire satisfaction of the Contract Administrator. At the end of each working day all their own rubbish shall be cleared away. The Services Contractor shall ensure that all rubbish, waste and offcuts etc. are cleared away in accordance with the Main Contractors waste management plan.

1.27 BUILDING CONTROL (AMENDMENT) REGS 2014

1.27.1 A works inspection plan shall be applied to this project, in accordance with S.I. No.9 of 2014 and the contractor shall include for all costs associated with contractor/sub-contractor duties required under same. Refer to the main contract preliminaries and 'Addendum To Preliminaries Document' as prepared by the Assigned Certifier for details of the required inspections and contractor duties under the works. If in any instance it is found that an item of plant or equipment has been installed that is not in compliance with the agreed installation methodology and/or specification, the Contractor will be required to remove/rectify/replace the installation/equipment/plant in question at no expense to the client.

2 GENERAL CONDITIONS OF CONTRACT

2.1 PROJECT PARTICULARS

PROJECT/SITE	Mechanical Services Installation at Clonmel Courthouse, Tipperary
CLIENT	Tipperary County Council
SERVICES ENGINEERS	J.V Tierney & Co., Consulting Engineers, The Tannery, 53-56 Cork Street Dublin D08 P92R
PROJECT ARCHITECTS	OC + C Architects
STRUCTURAL/CIVIL ENGINEER	O'Connor, Sutton, Cronin
QUANTITY SURVEYOR	Brendan Merry & Partners

2.2 BASIS OF CONTRACT

2.2.1 The particulars of the contract are detailed in the main contract specification, to which the Mechanical contractor shall refer prior to submitting their tender.

2.3 EXAMINATION OF SITE

2.3.1 Mechanical Contractors tendering are strongly advised to inspect the site before completing their tender in order to acquaint themselves with the local conditions including access to the site, the conditions that may affect labour and to ascertain the exact amount of work involved in the installation of new mechanical services, interconnections and alterations required to existing mechanical systems under the proposed works.

2.3.2 The Contractor may visit the site at any time, however they must liaise with the Engineers' to organise access.

2.3.3 Should the contractor identify any details during their inspection that conflict with the data they shall bring this to the attention of the engineer in writing before their tender is submitted.

2.3.4 The Services Contractor shall visit site during the tender period and shall have satisfied themself of the following:

1) Local conditions
2) Nature and accessibility of the site
3) The nature and extent of the operations
4) The supply of and conditions affecting labour.
5) Storage space for materials
6) Position of underground services and drains
7) Space available for the execution of the works generally.

2.3.5 The Services Contractor shall include in their tender for all costs necessary to take account of the above and arrange for their delivery of materials so that no congestion occurs and shall include for all additional handling and transporting due to site conditions.

2.3.6 No claim shall be allowed in the settlement of the account in respect of aforementioned items, neither will the lack of knowledge or ignorance of conditions be accepted as justifying such a claim.

2.4 LIMITATIONS ON WORKING HOURS AND WORKING SPACE

2.4.1 Construction working hours deemed to be between 8.00am and 6.00pm Monday to Friday.

2.4.2 Saturday working hours deemed to be between 8.00am and 1.00pm. No works are authorised to be completed on Sundays.

2.4.3 “Noisy” works and all other operations likely to cause undue disturbance to building occupiers and other building users are to be undertaken outside of normal working hours upon the instructions of the engineer or client’s representative at no extra cost to the contract.

2.5 PROGRAMME FOR COMPLETION OF WORKS

2.5.1 The contract works shall be carried out in accordance with a Building Programme to be agreed with the Client, tenant and Engineer.

2.5.2 shall so arrange the works, such that they shall not unduly disrupt the routine business of the client.

2.5.3 The contractor shall note that the building will remained occupied during the construction period and that no works can be carried out in the corridors or public areas during normal working hours. Works in these areas shall be confined to Saturdays and Evenings.

2.5.4 The contractor shall prepare and submit a master programme clearly showing their proposed sequence and timing of the works. The programme should include procurement, construction test and commissioning and handover with all key elements identified with a clear critical path.

2.5.5 The programme shall be produced as a bar chart, two copies of which shall be given to the engineer or client's representative and one kept permanently on site. Actual progress achieved shall be reviewed and measured against this programme at each site meeting. It shall be updated on a weekly basis by the contractor and issued to the Engineer.

2.6 PROJECT DESCIPTION

2.6.1 The project involves the supply, installation, testing and commissioning of the Mechanical Services. Scheduled below is a brief list of the services, this list is not exhaustive and is provided to give a general understanding of the works only:

1) Site services- Incl. survey of external and internal plants.
2) Foul drainage Above Ground
3) Hot, Cold & Mains Water Services
4) Heat Source
5) Ventilation Services.
6) Associated Controls Cabling

2.6.2 Please refer to Main Contractor's specification for a full description of the overall works.

2.7 COMMISSIONING

2.7.1 The Contractor shall be responsible for commissioning the entire mechanical services for all phases and stages of the installation to the satisfaction of the Engineers. The Contractor shall produce for the approval of the Engineers a detailed specification for commissioning Procedures for the completed installation. This Specification shall be provided well in advance of the commissioning programme and at a time agreed with the Main Contractor.

The Commissioning Procedures Specification shall include the following:

(a) Detailed operating programme.
(b) Bar chart showing weekly analysis of programme.
(c) Data to be used for each stage of commissioning.
(d) Detailed commissioning schedules for each item of plant and equipment.
(e) Requirements and involvement of Consultant/Resident Engineers and building staff.
(f) Method of logging all performance data with processing and issuing to Clients representatives.
(g) Method of issuing certificates including suppliers certificates.
(h) Instruments and method of measurement to be used in commissioning.
(i) Instructing Staff in use of plant and systems.

2.7.2 The Contractor shall co-ordinate with the Electrical Contractor in arranging a seminar to present and explain the commissioning methods and programme they proposes for the installation. They shall also arrange for all specialist suppliers/installers involved in the mechanical installation to be in attendance to outline their own commissioning procedures.

2.7.3 The Contractor shall include for the complete testing and commissioning of all sections of the mechanical services installation prior to the Date of Practical/Substantial Handover. Prior to this date the contractor shall also ensure that all test and commissioning certificates and as-made drawings and manuals are handed over to the consulting engineers. After substantial completion the Client shall carry out further fit-out works. At the end of the Client's fit-out works the contractor shall include for re-commissioning the entire installation and verifying the original test and commissioning results.

2.8 BUILDING CONTROL (AMMENDMENT) REGS 2014

2.8.1 A works inspection plan shall be applied to this project, in accordance with S.I. No.9 of 2014 and the contractor shall include for all costs associated with contractor/sub-contractor duties required under same.

2.8.2 If in any instance it is found that an item of plant or equipment has been installed that is not in compliance with the agreed installation methodology and/or specification, the Contractor will be required to remove/rectify/replace the installation/equipment/plant in question at no expense to the client.

2.8.3 All works shall be carried out to the new Building Control (Amendment) Regulations [BC(A)R], S.I. 9 of 2014, and therefore the Contractor shall allow for the following over the subsequent stages of the contract:

COMMENCEMENT STAGE

- Familiarise themselves with the drawings, specifications and documents lodged with the Commencement Notice.
- Ensure a competent person is assigned to oversee the Construction works.

DURING CONSTRUCTION

- Install the services and construct the building in accordance with the plans and specifications.
- Ensure that the workmanship complies with the requirements of the Building Regulations.
- Ensure that materials which they select and for which they are responsible comply with the requirements of the Building Regulations.
- Cooperate with the Design Team, the Assigned Certifier and other Certifiers (Clerk of Works and other Client Technical personnel).
- Cooperate with the Assigned Certifier for the implementation of the site inspection plan, and cooperate with any other client inspections.
- Address all items raised by the designers in the site inspection reports in a timely manner. Issue updates to the site inspection reports to confirm: status of all items raised; actions taken to address issues; advise when items are complete for review; provide photographic evidence of actions complete.

UPON COMPLETION

- Sign the Certificate of Compliance (Completion).
- Provide to the Assigned Certifier, such documents for which they are responsible, as may assist the Assigned Certifier to collate particulars for the purposes of handover and certification, and/or for further submissions to the Building Control Authority.
- Ensure the coordination and provision of all test certificates and confirmations to the satisfaction of the Assigned Certifier or other designated Inspectors or Certifiers providing Ancillary Certificates.
- Maintain records.

PHOTOGRAPHIC EVIDENCE

2.8.4 The Contractor shall allow for photographing the mechanical installation on a bi-weekly basis for records. These photographs shall be detailed in a weekly report, which highlights what works were carried out and shall include photographic evidence of that work. These reports shall be submitted to the Building Contractor on a bi-weekly basis for inclusion in the progress report. These reports shall be signed and witnessed by the Building Contractor.

2.8.5 At the end of the project, the Contractor shall include a copy of these reports in the Operation and Maintenance Manual.

2.8.6 The Contractor shall allow for submitting photographic evidence on the following over the course of the project:

- All mechanical services above the ceiling including all cabling and associated pipework and ductwork support installations.
- All mechanical services below ground level including any underground gas pipework installed. Evidence to be taken and approved before filling in ground.
- All mechanical services to be included in voids, walls, building fabric, etc. Evidence to be taken and approved before services are covered.
- Photographic evidence of all fire damper installations. Include picture of type of cabling terminations that is being installed.
- Photographic evidence of all fire collar installations.
- Any other works deemed necessary.

2.9 METERING

2.9.1 All energy metering installed shall comply with the Measuring Instruments Directive 2014/32/EU.

2.9.2 Types proposed shall be chosen to suit the application, static pressure and pressure drop. The meter range and turn-down ratio shall be chosen such that the full anticipated flow range is measured within an accuracy of +/-2% or better. No positive displacement types shall be employed where safety is jeopardised by lack of flow. Flow meters shall supply a pulse output (max 25Hz at full rated flow) or 4-20mA.

2.9.3 All flow metering devices shall be supplied complete with any output transducers and supplied with individual over-all calibration chart. The BEMS Specialist shall advise the engineer of any isolating valves or by-pass circuits thought necessary for instrument service and maintenance of flow.

2.9.4 This complete metering installation shall be fully networkable and capable of pulse outputs for remote monitoring. The quantity of meters shall be as indicated on the Drawings. Meters shall comply with the current EU regulations on Energy Performance of Buildings and shall be capable of cumulative recording of power usage statistics in the building. The central control unit shall be capable of preparing power usage reports on weekly, monthly and annual basis.

3 PIPEWORK INSTALLATION

3.1 STANDARDS

3.1.1 All pipework and components shall be selected, manufactured and installed in accordance with the latest version of all applicable BS/BS EN/BS EN ISO and CIBSE/HVCA standards (some of the key standards are scheduled below) and as detailed in this specification.

STANDARDS	
CIBSE GUIDES	BS EN 1057 – copper pipework
BS 143 and BS 1256 Malleable cast iron and cast copper alloy threaded pipe fittings	IS 3213:1987 Storage of LPG cylinders and cartridges
IS 3216:2010 – Code of Practice for the Bulk Storage of LPG Part 1 General Requirements	IS820:2010 Non Domestic Gas Installations
IS329:2003 Gas Distribution Mains	IS 265 Installations of gas services pipes
BS 7291:2010 Thermoplastic pipe and fitting systems.	BS 1710:2014 Specification for identification of pipelines and services.

3.2 PIPEWORK ABBREVIATIONS

3.2.1 The following acronyms used throughout this section of the specification and elsewhere shall have the following meanings;

- LPHW - Low Pressure Hot Water (Heating Systems)
- MWS – Mains Water Services
- CWS – Cold Water Services
- HWS – Hot Water Services
- HWR – Hot Water Return
- RWS – Rain Water Harvested Services
- MDPE - Medium Density Polyethylene
- HDPE - High Density Polyethylene
- PEX – Cross linked polyethylene
- MLCP Multi-Layer Composite Pipe

3.3 PIPEWORK GENERAL

3.3.1 The pipework should have a guarantee against any material or manufacturing defect for a period of 25 years under normal service conditions. This shall apply to all types of mains fed and pressurised plumbing systems and both open-vented and sealed heating systems subject to the operating limits specified in BS 7291.

3.4 WALL AND FLOOR SLEEVES

3.4.1 In all places where pipes pass through walls or floors suitable sleeves shall be provided and fitted in at such points. Sleeves shall be in one length consisting of similar piping to the installation and shall be fixed flush with the finished surface of the floor or wall.

3.4.2 Sleeves shall be of ample diameter to allow for the movement of mains and branches due to expansion and contraction. The pipes passing through these sleeves shall be fixed correctly to allow for this movement. This also applies to holes in floors or ceilings where it is not possible to fix sleeves. The Contractor shall be responsible for any damages caused to the building or to the installation through leakage or otherwise due to neglect in this matter.

3.5 WALL, FLOOR AND CEILING PLATES

3.5.1 In all positions where exposed pipes pass through walls or floors the holes shall be covered with suitable plates to the approval of the Engineers. All plates shall be polished chromium plated or otherwise as approved.

3.6 PIPE SUPPORTS

3.6.1 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.

3.6.2 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.

3.6.3 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.

3.6.4 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 an 0.8mm layer of brass plate.

3.6.5 All sharp edges and cut ends on pipe supports, brackets, etc. shall be suitably protected.

3.6.6 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:-

STEEL PIPEWORK		
Size (mm)	Horizontal	Vertical
15	1.8m	2.4m
20	2.4m	3.0m
25	2.4m	3.0m
32	2.7m	3.0m
40	3.0m	3.7m
50	3.0m	3.7m
65	3.7m	4.6m
80	3.7m	4.6m
100	4.0m	4.6m
125	4.5m	5.5m
150	5.5m	5.5m
200	8.5m	8.5m
250	9.0m	9.0m
300	10.0m	10.0m

COPPPER PIPEWORK		
Size (mm)	Horizontal	Vertical
15	1.2m	1.8m
22	1.2m	1.8m
28	1.8m	2.4m
35	2.4m	3.0m
40	2.4m	3.0m
54	2.7m	3.0m
67	3.0m	3.7m
76	3.0m	3.7m
108	3.0m	3.7m
133	3.7m	3.7m
159	4.5m	3.7m

3.7 CONTROL VALVES

3.7.1 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.

3.7.2 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.

3.7.3 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.

3.7.4 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.

3.7.5 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 BS EN 12266. 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 BS EN 12266.

3.7.6 Automatically closing valves and/or vent valves operated from gas, fire or smoke detection systems shall be to BS 7461: 1991 and IS EN 161, operated by solenoid or electro-hydraulic actuator for fast or slow opening, as appropriate.

3.8 COMMISSIONING SETS

3.8.1 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 ± 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.

3.9 CLEANING FOR PAINTING

3.9.1 After erection and testing have been completed and passed by the Engineers all uncovered piping, and brackets shall be thoroughly cleaned, scraped, and left smooth for painting.

3.10 RUN OF PIPING

3.10.1 Although the run of piping is shown as accurately as possible on the drawings the Contractor shall be responsible for arranging such runs both vertical and horizontal so as to avoid unsightliness. Where such arrangements involve special fittings or settings of piping even though not shown on the drawings such fittings shall be provided under this contract. The Contractor shall set out the run of their pipes and obtain the Engineers approval of their arrangement before fixing the pipes.

3.11 CONNECTION TO FIXTURES

3.11.1 The Contractor shall provide for running dead leg connections and connecting up to the various fixtures, sanitary fittings, etc. all as shown on the drawings.

3.11.2 Piping between the circulating piping and the various fixtures shall be neatly run in a manner approved of by the Engineers. All sanitary fittings shall be mounted and fixed in position under another Contract.

3.11.3 All connections to WHBs, WCs, sinks and showers shall be fitted with in-line ball valves. From the ball valves, half hard copper tails shall be rigidly connected to final outlet positions. Flexible connections shall not be accepted. The mechanical contractor shall liaise with the main contractor and review the sanitary ware schedule to ensure this aspect of the works is carried out.

3.12 LPHW PIPING

3.12.1 Pipework up to 150mm shall be fabricated from black steel tube to BS EN 10255:2004 or equivalent, ungalvanised medium grade.

3.12.2 Pipework 200mm to 450mm shall be to BS EN 10216-1:2002 AND BS EN 10217-1:2002 and be of hot finished electric resistance welded construction from steel with minimum tensile strength of 360N/mm2, unless indicated as seamless.

3.12.3 Fittings shall be to IS EN 10253 or equivalent, though in locations where pipework up to and including 50 mm is exposed, BSP screwed connections may be permitted to BS 143 and 1256: 2000 with the approval of the Engineer. The piping installation shall be welded through out. All LPHW pipework shall be welded through out, with the exception of threaded joints for valve/plant connections and allowance for disconnection/removal of pump/valve assembly arrangements.

3.12.4 Suitable spherical seated unions shall be used on pipework up to and including 50 mm for connection to valves and equipment and to permit easy dismantling of pipework.

3.12.5 On pipework 65 mm and above flanges shall be used to BS 6560-3.2: 1989 as appropriate for the temperatures and pressures specified.

3.12.6 Care shall be taken in supporting and levelling all piping and in the layout generally to ensure that the correct gradient is maintained throughout, and that air locks are not possible. Pipes shall be arranged in such a manner that they can expand freely without undue strain.

3.12.7 Care shall be taken to prevent dirt or rubbish getting into the pipework during erection. Timber or metal plugs shall be used for this purpose. Should any stoppage occur in the circulation owing to the foregoing causes, the Contractor shall attend to and rectify any such trouble at their own expense.

3.12.8 Special care shall be taken in fitting pipework to ensure that no damage shall be done to structure, furnishings, etc. and the Contractor shall take full responsibility for any such damage caused.

3.13 EXTERNAL HEATING & WATER PIPEWORK

3.13.1 External Potable Water, CWS, and LPHW piping shall be carried out using pre-insulated direct burial flexible PEX piping. The extent of external piping is indicated on contract drawings. The pre-insulated pipework for potable water & CWS shall be WRAS certified.

3.13.2 External heating mains shall be carried out using pre-insulated P.E.X. pipework jointed by the polyfusion method. The pipework shall consist of P.E.X. inner pipe suitable for operating at 95 degrees C continuously and 120 degrees C intermittently with P.E.X. insulating foam and HDPE outer jacket. The pipework shall be installed in single unbroken runs between the boiler house and extension. Joints between P.E.X. and G.B. pipework shall be made over floor level. Any below ground joint shall use proprietary fittings supplied by the pipe manufacturer.

3.13.3 The pipes shall be laid in the trench on 100mm of sand and covered with a minimum of 150mm of sand strictly in accordance with the manufacturer's recommendations. The 110mm P.E.X pipework shall transition to 100mm steel pipework at a distance of 1 metre (1m) inside the building.

3.13.4 The handling and installation shall be carried out according to the recommendations of the manufacturer and the EU HP Association. Before back filling, the pipes shall be surrounded with 100mm of compacted PCA gravel and buried to a minimum depth of 500mm.

3.13.5 The supervision of the installation and demonstration of the correct procedures, particularly regarding the jointing shall be undertaken by the suppliers. Completion certificates will only be issued on the understanding that the work has been carried out according to the manufacturer's recommendation and that all stages of the work have been examined and checked by the manufacturer's agent.

3.13.6 The Contractor shall ensure that all welders are coded and shall submit a current certificate in respect of each operative. For pipes with a wall thickness <3mm gas welding shall be used. For pipes with a wall thickness >3mm electrical arc welding is preferred. The gas welding shall conform to B.S. 260 Class 2 oxyacetylene welding of carbon steel pipework. For electric are the welds shall conform to BS 2971 are welding of carbon steel class 2.

3.13.7 Particular care shall be exercised to ensure that the pipes are correctly bevelled where required and that the appropriate gas is established at the joints in order to achieve good adhesion and full penetration.

3.13.8 On completion of the welding but before jointing, the pre-insulated pipe shall be air pressure testing up to 5 Bar before an hydraulic pressure test of 7 bar is applied for 2 hours.

3.13.9 The jointing shall be executed using the manufacturers double seal enclosures with pre-insulated pipe end caps shall be fitted and shrunk over the pipe ends.

3.13.10 The manufactures ties, bends, offsets etc. shall be used throughout strictly to manufactures specification. The manufactures calculations and recommendations shall be adhered to where expansion take-up is required where indicated on site drawings.

3.14 MULTI-LAYER PIPING

3.14.1 Where specified multi-layer composite piping shall be with an aluminium inner pipe approved to ISO 9001. The piping will contain four layers (PE-X/adhesive/adhesive/PE-X)

3.14.2 The mains water services installations shall comprise of Presstite Multilayer Pipe PE-Xc/Al/PE-Xc as supplied by Polytherm or equal and approved.

3.14.3 The specially designed press fitting which comprises of a brass body and a stainless steel sleeve ranging from (16mm, 20mm, 26mm, 32mm, 40mm, 50mm & 63mm)

TYPE	ALUMINIUM THICKNESS (MM)
16 x 2mm (100MT COIL)	0.4
20 x 2mm (100MT COIL)	0.5
26 x 3mm (50MT COIL)	0.6
32 x 3mm (50MT COIL)	0.8
32 x 3mm (5MT LNS)	0.8
40 x 3.5mm (5MT LNS)	1.0
50 x 4mm (5MT LNS)	1.2
63 x 4.5mm (5MT LNS)	1.5

3.14.4 Each of the four layers (PE-X/adhesive/adhesive/PE-X coating) of the Multilayer pipe shall be produced by a separate extruder.

3.14.5 Multilayer pipe to be laid out for a durability of 50 years in accordance to DIN EN ISO 21003.Fitting are to be made of dezincification brass. The press sleeve is to be made of stainless steel and is equipped with viewing windows to control the depth for tube plug in. This is to be connected to the fitting by means of an insulated ring. All the materials that could be in contact with potable water fulfil all requests of the standards DVGW W 534 and DVGW W 270.

3.14.6 Joints to be press fittings formed from an approved Press Tool in accordance with the requirements of the piping and the manufacturers recommendations.

3.14.7 The Contractor shall include for connecting to tap outlets unless otherwise indicated. The contractor shall be responsible for ensuring there are no dead legs on the system and in certain cases where required, they shall be fitted with drain valves for maintenance purposes to the approval of the Employers Representative/Consulting Engineer. The contractor shall remove dead legs at no extra cost should they be identified during the course of the works. The water services installation shall comply with local water bye-laws, BS 6700.

3.14.8 All bends shall be as far as possible made from the piping. Sizes up to 38 mm. bore shall be made with spring bending tubes and in no case shall the radius be less than 3 dia. of the tube.

3.15 REFRIGERANT PIPING

3.15.1 All refrigerant pipework shall be designed for the minimum pressure drop which ensures that refrigerant liquid leaving the compressor is carried through the system and back to the compressor at the lowest stage of capacity unloading.

3.15.2 Where systems are built-up at site, oil separators, oil reservoir and automatic oil return equipment shall be provided.

3.15.3 Design shall ensure correct refrigerant distribution to evaporators with no liquid refrigerant drainage into the compressor during shut-down, or liquid entry during operation, and shall avoid lubricant accumulation and slugging in the suction line.

3.15.4 Copper suction, discharge and liquid lines up to 105mm outside diameter shall be fabricated from refrigeration quality tube to BS 2871: Part 2, Table 2, material designation C106. Tube shall be fully annealed up to 22mm O/D only.

3.15.5 Tube shall be delivered to site internally degreased and be stored in clean and dry conditions, with ends sealed until required for installation.

3.15.6 Joints in copper piping systems may be flared up to 19mm O/D only, flanged or brazed (with or without capillary fittings). Compression fittings shall not be used, except as specified.

3.15.7 Brazing shall be carried out in accordance with BS 1723. Brazing rods shall be cadmium-free and to BS 1845.

3.15.8 Piping shall be firmly supported, arranged to minimize vibration and as specified. Vibration eliminators shall be fitted to the compressor suction and discharge pipes to minimize transmission of vibration or noise.

3.15.9 Provision shall be made to accommodate thermal expansion and contraction. 'Cold bridging' shall be prevented.

3.15.10 System piping including site assemblies shall be subjected to pressure and leakage tests.

3.15.11 Copper suction, discharge and liquid lines up to 105 mm shall be fabricated from refrigerant quality tube to IS EN 12449 : 1999. Tube shall be fully annealed (up to and including 22 mm O.D. only) and internally degreased and cleaned.

3.15.12 Joints in copper pipe shall be flanged, flared (up to 22 mm O.D. only), or brazed. Brazing shall be carried out to the requirements of the HVCA Code of Practice TR3 and IS EN 13133:2000 and IS EN 13134:2000. Brazing rods shall be cadmium-free and conform to IS EN 1044: 1999.

3.15.13 Refrigerant piping shall be supplied sealed from the manufacturer to avoid contamination. Oxygen-free nitrogen shall be used during brazing to prevent oxidation.

3.15.14 Welders and brazers shall be approved in accordance with the **relevant section** of this Specification.

3.15.15 The pipework shall be designed for the minimum pressure drop which ensures that oil in the refrigerant leaving the compressor and passing into the system shall be carried through and back to the compressor at the lowest stage of capacity unloading.

3.15.16 Design shall ensure correct refrigerant distribution to evaporator(s) with no liquid refrigerant drainage into compressor(s) during shutdown nor liquid entry during operation, and avoidance of lubricant accumulation and slugging in the suction line.

3.15.17 Where applicable, the Contractor shall ensure that the maximum length of refrigerant pipework between indoor and outdoor units is within the limiting distance permitted by the manufacturer.

3.15.18 To minimise the possibility of refrigerant losses to atmosphere, pipework joints shall be kept to a minimum.

3.15.19 Pipework shall be firmly supported in accordance with the **relevant section** of this Specification and shall be complete with suitably sized galvanised tray to support and secure piping and control wiring from condenser to room units. Vibration eliminators shall be fitted to the compressor suction and discharge pipes to minimise transmission of vibration and noise. Provision shall be made to accommodate thermal expansion and contraction.

3.15.20 All valves and components shall be installed so that they are accessible for inspection and maintenance.

3.15.21 Thermal insulation shall be in accordance with the relevant section of this Specification.

3.15.22 Refrigeration equipment shall have a strength pressure test and a leakage pressure test after manufacture. Tests on the refrigerant side shall be made in accordance with IS EN 3-3, 6&778.

3.15.23 A strength pressure test shall be applied to the refrigerant system. The required test pressure shall be in accordance with IS EN 3-3, 6&778. Water-side pressure tests shall be 1.5 times the working pressure.

3.15.24 A leakage pressure test shall be applied to the refrigerant system after all piping has been fitted. This test shall be in addition to the strength pressure test on each unit at completion of manufacture. The required test pressure shall be as shown in IS EN 3-3, 6&778.

3.15.25 After testing of the pipework system, vacuum shall be applied to less than 2kN/m2. This vacuum shall be applied for 24 hours without decrease after which the system shall be charged with refrigerant.

3.16 COPPER PIPING

3.16.1 Domestic hot and cold water and above ground mains water pipework shall be fabricated from hard copper tubing to IS EN 1057: 2006.

3.16.2 Copper fittings shall be lead-free solder ring capillary type to IS EN 1254 : 1998, though in locations where pipework up to and including 54 mm is exposed, compression fittings to IS EN 1254 : 1998 may be permitted with the approval of the Engineer. Fittings shall be resistant to dezincification and shall be fully compatible with the copper tubing.

3.16.3 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 BS EN 1560-3.2: 1989. The water services installation shall be brazed/ soldered throughout. Compression fitting/joints shall only be acceptable where valves etc are required and at connection points to sanitary ware fittings and appliances. All piping shall be concealed, dropping in stud, IPS unit and boxing as required and approved by the design team.

3.16.4 The Contractor shall include for connecting to sanitary fittings, shower mixing valves, and tap outlets unless otherwise indicated. The contractor shall be responsible for ensuring there are no dead legs on the system and in certain cases where required, they shall be fitted with drain valves for maintenance purposes to the approval of the engineer. The contractor shall remove dead legs at no extra cost should they be identified during the course of the works. The water services installation shall comply with local water bye-laws, BS 6700 and HTM04-01 requirements.

3.16.5 Where indicated, exposed external water services pipework shall be trace heated in accordance with the relevant Section of this Specification.

3.16.6 All bends shall be as far as possible made from the piping. Sizes up to 38 mm. bore shall be made with spring bending tubes and in no case shall the radius be less than 3 dia. of the tube.

3.17 PLANT ROOM PIPEWORK

3.17.1 All heating pipework in the plant room shall be carried out in “medium blue band” steel, black steel tube to BS EN 10255:2004 water quality piping. The jointing of all main pipework to the boiler, etc. shall be M.S. faced flanges and joint rings, bolted together to B.S.S. table “D”.

3.17.2 All necessary brackets, pipe hooks and rings including any special brackets that may be required shall be supplied and fitted. The entire pipework in the boiler house shall be rigidly supported. All boiler room LPHW pipework shall be welded throughout, with the exception of threaded joints for valve/plant connections and allowance for disconnection/removal of pump arrangements. Boiler house piping shall be insulated and clad through-out c/w valve insulated jackets provided.

3.18 IDENTIFICATION COLOURS FOR PIPING

Service	Colour	BS 4800:2011 colour code	Example (RGB)
Basic identification colours			
Water	Green	12 D 45	
Steam	Silver-grey	10 A 03	
Oils – mineral, vegetable or animal Combustible liquids	Brown	06 C 39	
Gases in either gaseous or liquefied condition (except air)	Yellow ochre	08 C 35	
Acids and alkalis	Violet	22 C 37	
Air	Light blue	20 E 51	
Waste effluents	Black	00 E 53	
Electrical services and ventilation ducts	Orange	06 E 51	
Safety colours			
Fire	Red	04 E 53	
Water from a public supply	Auxiliary blue	18 E 53	
Water from any other source	Flint grey	00 A 09	
Warning	Yellow	08 E 51	
Code and other colours			
Refrigeration	Blue	18 E 51	
Medical gases and refrigeration	Golden brown	06 D 45	

Service	Colour	BS 4800:2011 colour code	Example (RGB)
Building services and refrigeration	Crimson	04 D 45	
Building services and refrigeration	Emerald green	14 E 53	
Building services	Salmon pink	04 C 33	
Building services and medical gases	Primrose	10 E 53	
Building services and medical gases	White	00 E 55	
Medical gases	French grey	12 B 21	
Medical gases	French blue	20 D 45	
Refrigeration	Sea green	16 C 37	
Refrigeration	Dark mauve	02 C 37	

3.18.1 BS 4800:2011 shall be specified when ordering. Names above and on the previous page are given for indicative purposes only as different manufacturers' may attribute different names.

3.18.2 All pipework shall be labelled and identified in accordance with the requirements of BS: 1710.

3.18.3 Directional flow arrows shall be included in the banding of all piping systems. In addition for central heating it is necessary to separately indicate the flow and return pipes, the directional flow arrows shall be supplemented by the use of the word FLOW on the one pipe and the word RETURN on the other.

4 THERMAL INSULATION

4.1 GENERAL

4.1.1 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.

4.1.2 Thermal insulation and methods of application shall comply with BS 5422: 2001 and BS 5970 and manufacturer's recommended procedures. Thermal insulation of buried services shall comply with BS 4508. Thermal insulating materials shall comply with IS EN 13166:2001 AMD1: 2004, BS 3958 and BS 5608 as appropriate.

4.2 FIRE SAFETY

4.2.1 Unless otherwise indicated, thermal insulating materials shall, when tested in accordance with BS 476, 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.

4.2.2 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.

4.3 EXCLUDED MATERIALS

The following materials shall not be used:-

- Materials containing mineral fibres which are not contained or stabilised by materials to prevent migration.
- Insulation using CFCs or HCFCs in their manufacture.
- Materials having asbestos content.
- Polystyrene material.
- Self-adhesive 'soft' tapes which do not ensure long term adhesion.

Wire netting reinforcement shall not be used in contact with stainless steel

4.3.1 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.

4.3.2 Insulating materials shall be suitable for systems minimum and maximum temperatures.

4.3.3 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.

4.3.4 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.

4.3.5 All materials delivered to the site shall be new and dry, and so maintained throughout the progress of the works.

4.3.6 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.

4.3.7 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.

4.3.8 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.

4.3.9 The Contractor shall remove all foreign matter from the surface to be insulated.

4.3.10 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.

4.3.11 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 their own expense.

4.3.12 All insulation must be dry and applied over dry surfaces. Where the Contractor must leave an item unfinished, e.g. overnight, they shall provide temporary weatherproofing.

4.3.13 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.

4.3.14 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.

4.3.15 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.

4.3.16 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.

4.3.17 Where insulating materials are finished with metallic cladding, the cladding shall be bonded by the electrical contractor in accordance with current ETCI Wiring Regulations.

4.4 SERVICES TO BE INSULATED

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

4.4.1 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 space in addition to the heat emitter.

4.4.2 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.

4.4.3 Pipework, vessels, etc. in a heat recovery, refrigeration or chilled water system.

4.4.4 Steam and condensate systems including accumulators, pipework, hot wells, condensate receivers and boiler blowdown pipes. Condensate cooling legs shall not be insulated.

4.4.5 Safety valve discharge pipes for steam, heating and hot water where required to prevent danger to personnel.

4.4.6 Supply air handling plant including heater or cooler batteries with intake ductwork to plant insulated to prevent condensation.

4.4.7 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.

4.4.8 Air extract ducting to atmosphere – where such ducting passes through occupied areas and contributes to the heat gain/loss of the occupied area.

4.4.9 Any pipework with heated/cold/chilled fluid, within hollow partition, boxed in, floor screeds and all pipework subject to potential frost conditions.

4.4.10 Instruments and gauges shall be clear of the insulation.

4.5 INSULATION MATERIALS

Ref	Insulating Material	Typical Temp Range	Typical 'K' Value W/Mk At Mean Temp Oc	Typical Material Density Kg/M2
CS	Calcium silicate preformed pipe, lags and slab sections.	Up to 650oC	.058 @100	Not less than 210
GF RF	Bonded preformed manmade glass/rock fibre mats and mattresses.	Up to 300oC	.044 @ 100	GF not less than 50 / RF not less than 65
GF RF	Bonded preformed manmade glass/rock fibre pipe sections.	Up to 230oC	.043 @ 100	GF: 80-100 RF: 130-150
GF RF	Bonded manmade mineral fibre slabs. Long fibre classification only	51oC to 400oC	.047 @ 100	GF: 48+ RF: 65+
GF	Flexible mattresses.	Up to 230oC	.065 @ 100	GF: 20
RF			.044 @ 100	RF: 90
PF	CFC-free Phenolic Resin (Foam) insulation. Pipe, sheet and slab sections.	-180oC to +120oC	.02 @ 10	Not less than 35
ENR	Expanded nitrile rubber (Class 'O' only).	-40oC to +150oC	.036 @ -10 and .041 @ +20	Not less than 65

4.6 PROTECTIVE FINISHES

4.6.1 Finishes shall be shaped to suit the installation with 40mm overlaps at joints arranged to shed water.

Internal coverings

4.6.2 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.

4.6.3 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.

Cladding

4.6.4 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.

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

4.6.6 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.

External Service

4.6.7 All external L.P.H.W, chilled water, water supervision, pipes shall be in insulated, opponal wrapped and clad.

4.6.8 All external LPHW, sprinkler, water services pipework will be heat traced to prevent freezing.

4.6.9 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.

Vapour Barriers

4.6.10 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.

4.6.11 Unless otherwise indicated, the vapour barrier shall have a permeance value not exceeding 0.15g/(sMN) for chilled water pipework and equipment, 0.10g/(sMN) for refrigeration work (cold surfaces 0oC) and 0.05g/(sMN) for other applications.

4.6.12 The material selected for the vapour barrier and its method of application shall be compatible with the thermal insulation which it is to protect.

4.6.13 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.

4.7 PARTICULAR ITEMS

Pipework Supports

4.7.1 At 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.

4.7.2 At 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.

4.7.3 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.

4.7.4 Vapour barrier and finish shall be carried over the support liners.

4.7.5 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.

Ductwork Supports

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

Support Inserts

4.7.7 Support inserts shall generally be shaped “crocodile” blocks of hardwood timber to matching outside dimensions, all combined with the cladding. Where phenolic foam insulation is used, inserts shall be shaped blocks of high density phenolic resin to match outside dimensions, all contained within the cladding.

Valve, Flange and Strainers Cover Boxes

4.7.8 Unless otherwise indicated, insulated valve, flanges and strainers shall be fitted with removable covers with suitable fasteners, lined with insulation as for pipes.

They 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.

4.7.9 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.

4.7.10 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.

4.7.11 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.

4.7.12 The glands on valve spindles shall project beyond the insulation. Insulated valve jackets shall be installed.

4.7.13 External valve and flange boxes shall be suitably weatherproofed and sealed as for the pipework to which they are attached.

Ductwork Flanges

4.7.14 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.

Expansion Joints

4.7.15 Pipe expansion devices shall operate without interferences by insulation which shall be carried over such devices on close clearance sheet metal sleeves secured at one end only.

4.7.16 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.

4.7.17 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.

Insulation in External Trenches/Ducts

4.7.18 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.

Insulation in Floor Ducts/Screeds

4.7.19 Pipework installed in floor ducts shall be calcium silicate, phenolic foam or mineral fibre sections as applicable, with aluminium foil outer finish.

4.7.20 Pipework installed in floor screeds shall be insulated by packing plain finished mineral fibre mattress insulation beneath, between and above the services.

Equipment Insulation

4.7.21 Equipment shall be insulated using preformed rigid sections, bevelled lags or plain flat slabs radiused 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.

4.7.22 Equipment to be insulated generally includes boilers, tanks, cylinders, hot wells, steam and condensate receivers, flues, heater and cooler battery casings and system components.

4.7.23 Removable covers shall be provided on vessel maintenance manholes as detailed below, and inspection hand holes and vendors nameplates shall be left exposed.

4.7.24 Pump bodies shall be encased in formed removable metal casings with fasteners lined with the same insulation as fitted to adjacent pipes. Spaces within casings shall be filled with removable bonded flexible insulating material.

4.7.25 The Contractor shall make adequate provision, particularly on vertical faces, to prevent the insulating material from sagging i.e. by using insulation rings attached to the walls of the equipment.

Plant/Equipment Access

4.7.26 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.

Electric Tracing of Water Services Pipework

4.7.27 Pipework in exposed extreme situations shall be protected with electric tracing in addition to the thermal insulation specified in the relevant Section of this Specification. The mechanical contractor shall install IP67 self-regulating electrical trace heating tape on external piping along its complete lenght. The self-regulating heat tracing cables shall be certified for unconditional T-rating and have a maximum de-energised exposure temperature of 90 oC. The contractor shall include for the installation of foil back insulation, opponal wrap & cladding to all exposed piping installed under the works.

4.7.28 Electrical tracing tape rated at 12W/m is recommended (typically 16mm wide x 3mm thick flexible) and shall be attached to the surface of the pipe before it is insulated. The trace tape cabling shall be flexible and be complete with an outer jacket of sufficient thickness to provide adequate mechanical strength and chemical resistance. The system shall be self-regulating to compensate for variations in pipe heatloss, ambient temperatures and voltage.

4.7.29 For pipes up to and including 42mm, the tape should be attached longitudinally to the underside of the pipe. For larger sizes it should be wound helically around the pipe, spaced at about 3 turns per metre for 54mm pipe, and at about 4 turns per metre for sizes of 67mm and above.

4.7.30 A thermostat set to switch on the tape when the air temperature falls below 2oC shall be fitted in a position fully exposed to outside conditions but shaded from direct sunshine. A separate pipe sensor shall be provided to monitor the pipe medium temperature in series with the above. The tape shall be controlled by type CT capillary thermostats each rated 16 amps and having a range of 0 - 20 deg.oC. 1 No. thermostat shall control each run. The contractor shall liase with the manufacturer to confirm all installation requirements of the system proposed. The system shall be complete with control thermostats, Power supply modules, modular junction boxes and central controller for BMS monitoring of system status. The contractor shall include for installed 2 No. C rated 20A RCBO protected circuit breakers for the new supplies. The system shall be installed by the contractor to the manufacturers requirements, appropriately sized for the length of piping & cabling installed. The contractor shall provide all required wiring schematics and system loads to the electrical contractor.

4.7.31 Prior to installation, the Contractor shall submit details of the proposed trace heating system to the Engineer for review.

4.8 TABLE OF MATERIALS

4.8.1 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	LOCATION	FINISH MATERIAL
Steam	GF/RF	Plant room	Aluminium sheet
HTHW		Internal-exposed	Aluminium sheet
MTHW		Internal-concealed	Aluminium foil
Condense		External	Roofing felt
LTHW	GF/RF or PF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt
Chilled Water	GF/RF or PF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt
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	2 coats UV paint
Fresh air, supply and return ducting	GF/RF or PF	Plant room	Aluminium sheet
		Internal-exposed	Aluminium sheet
		Internal-concealed	Aluminium foil
		External	Roofing felt

4.9 INSULATION THICKNESS

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

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	40	Aluminium sheet and vapour barrier
Hotwells	Plantroom	RF/GF	100	Reinforced aluminium kraft foil
Cold water storage tanks	Any internal area	PF	40	Reinforced aluminium kraft foil

- Hot face temperature: 186ºC max.
- At 0ºC pipe inside temp, 30ºC ambient temp and 70% RH. Insulation material: ENR

4.10 PIPING/DUCTING INSULATION AND THICKNESS

Internal LPHW piping Installation

4.10.1 The whole of the piping where run in floor ducts, at high level and in roof space shall be insulated with foil backed rigid sectional fibreglass (Class "0" fire rating) fixed in accordance with the manufacturers recommendation.

4.10.2 All joints in the insulation, both circumferential and longitudinal shall be covered with FSK tape type 1535 securely fixed in accordance with manufacturers recommendations. Particular care shall be taken at elbows, bends and tees to ensure that these areas are completely and securely covered with insulation.

Insulation thickness shall be as follows:	
Sizes up to and including 32 mm. Bore	25 mm. thick
Sizes over 32 mm. and up to 50 mm. bore	32 mm. thick
Sizes over 50 mm. and up to 80 mm. bore	40 mm. thick
Sizes over 80 mm. Bore	50m. thick

4.10.3 The pipework shall be wire brushed, painted with 2 coats of red oxide paint then insulated as specified above.

External LPHW piping Installation (IF ANY)

4.10.4 The whole of the piping where external to the building, shall be insulated with foil backed rigid sectional fibreglass (Class "0" fire rating) fixed in accordance with the manufacturers recommendation.

4.10.5 All joints in the insulation, both circumferential and longitudinal shall be covered with FSK tape type 1535 securely fixed in accordance with manufacturers recommendations. Particular care shall be taken at elbows, bends and tees to ensure that these areas are completely and securely covered with insulation.

Insulation thickness shall be as follows:	
Sizes up to and including 32 mm. Bore	32 mm. thick
Sizes over 32 mm. and up to 50 mm. bore	40 mm. thick
Sizes over 50 mm. and up to 80 mm. bore	50 mm. thick
Sizes over 80 mm. Bore	65m. thick

4.10.6 The pipework shall be wire brushed, painted with 2 coats of red oxide paint, wrapped in Oppanol Sheeting, then insulated and clad in aluminium per above clauses.

Insulation of Ductwork (External)

4.10.7 Ductwork where carried externally shall be insulated with 50 mm thick duct insulation and covered with Oppanol weatherproof sheeting. The sheeting shall be fitted in strict accordance with the manufacturers' requirements to shed water. The ducting shall be finally clad in 22 gauge aluminium.

4.10.8 Where the ducting passes through external walls or roof, the Contractor shall provide a weatherproof skirting or flashing around the ducting riveted under the aluminium cladding. The Contractor shall provide a counter flashing around the skirting.

Insulation of Ductwork (Internal)

4.10.9 For rectangular supply and return air ductwork the contractor shall apply a 25mm thick fibreglass rigid duct insulation 48 kg/m^3 with a "k" value not exceeding 0.034 Watts/M2 Class O faced with glass reinforced aluminium foil paper laminate shall be applied strictly in accordance with the manufacturer's instructions.

4.10.10 For circular supply and return air ductwork the contractor shall apply a 25mm thick fibreglass blanket duct insulation 48 kg/m^3 with a "k" value not exceeding 0.034 Watts/M2 Class O faced with glass reinforced aluminium foil paper laminate shall be applied strictly in accordance with the manufacturer's instructions.

4.10.11 The insulation shall be cut to fit on site so that the top and bottom pieces overlap the sides. The insulation shall be bonded to the ductwork by means of a suitable adhesive applied in accordance with the manufacturer's recommendations. The insulation on the underside of the ducting shall be additionally secured by means of suitable insulation hangers at 300mm centre.

4.10.12 All insulation slabs shall be closely butted together and all joints shall be sealed by means of Idenden Class O self adhesive tape 100 mm. wide installed as per the manufacturers' recommendations. In order to maintain vapour barriers where the hangers penetrate the finish, insulation shall be sealed with Idenden self-adhesive tape or sealant. Any exposed edges of the insulation and any other points where the covering is penetrated shall be sealed with an Idenden adhesive/sealant.

Note: Supports for ductwork shall be arranged so that vapour barrier is not punctured. All the point of support 150mm long 18 gauge aluminium bearing sleeves shall be provide.

External LPHW piping Installation

4.10.13 The Contractor shall provide for insulating the whole of the pipework in loft space, ceiling space, at high level, where concealed and inducts/stud, including where piping shall drop to low level, with foil backed rigid sectional fibreglass (Class "0" fire rating) to the following thickness, fixed in accordance with manufacturers recommendations.

Sizes up to and including 40 mm. dia.	-	20 mm. thick
Sizes over 40 mm. dia.	-	25 mm. thick.

4.10.14 All joints in the insulating, both circumferential and longitudinal shall be covered with FSK tape T1535 fixed in accordance with manufactures recommendations.

5 PLANT ROOM INSTALLATION (ELEMENT 51)

The works covered in this section shall comprise the following:

1. Complete installation of proprietary air to water heat pump package inclusive of buffer vessel, pumps, valves, controls.
2. Complete installation of flow and return header, header circuit connections, twin circulating pumps, control mixing/diverting valves, within the plant room.
3. Complete installation of LPHW circuit pipework, insulation, cladding, valve jackets, control valve arrangements and associated pump sets.
4. Complete installation of Underfloor Heating installation including circuit pipework, pipework fixing system, UFH manifolds, insulation, control valve arrangements and associated pump sets.
5. Complete installation of associated water services piping, valve, and pressure reducing valves, automatic air valves, insulation and cladding.
6. Complete balancing and commissioning of the new systems.

5.1 PROPRIETARY AIR TO WATER HEAT PUMPS

3.1 The contractor shall include in the tender for the supply, installation and commissioning of an air to water packaged air source heat pump (ASHP) systems as detailed below:

The ASHP system shall be a monobloc type air to water heat pump unit with extremely silent operation. The units shall be hermetically sealed and factory tested outdoor units. The ASHP system shall include the following features:

- Noise Management System – to combine a large evaporator with minimal air resistance, a large variable-speed fan, special materials to dampen noise and vibration and a specially developed control logic to reduce noise to minimum levels.
- Weather Protection – to protect the evaporator's surface and protective guards against climatic conditions and maintain a constant and appropriate flow of air, first-level protection against indirect precipitation or flash freezes, small amounts of defrosting, higher efficiency, and more reliable operation. Designed to ensure the right amount of airflow through the evaporator even during snowstorms.
- Intelligent Adaptive Heating – control system to adjust the heat pump's output based on the building's requirements. Special control algorithms shall modify the temperature of the water in the heating system per the desired room temperature, the current ambient temperature indoor, and the current outdoor conditions.
- Refrigerant R290.
- Compressor Drive Heat Recovery System – electronic motor, designed for increased lifespan. System recovers waste heat to achieve more than 96% efficiency.
- Extremely large evaporator surface area for very low specific load and reduced extraction of humidity from the air and slower build-up of frost for less defrosting, greater effective heating capacity for the heat pump and increased efficiency for the whole system
- Designed for Enhanced Compressor Lifetime – an advanced oil recovery system shall ensure that the heat pump retains lubricant in its compressor. Compressor range monitoring and protection system to constantly maintain the system within safe parameters.

The unit shall consist of the following:

- Powder coated, zinced, steel plate housing
- Optionally made out of stainless steel or Corten sheet metal
- Evaporator and fan protected against the weather

- Bionically designed fan to minimize noise
- Adjustable heat output
- Adaptive heating
- Integrated circulation pump
- A large surface evaporator with a large gap between the fins
- Special acoustically insulated housing

Refer to the schedules for detailed performance requirements for 1No. 32kW rated unit.

5.2 LPHW FILLER/PRESSURISATION UNITS

5.2.1 Automatic fill unit(s) must be of the next generation microprocessor controlled intelligent type proprietary packaged unit mounted on a common base-plate in a robust metal casing, comprising 18 litre break tank c/w Category 5 A/B air gap, foot valve, twin pump, hydraulic accumulator, and all necessary controls, safety devices and power connections.

5.2.2 The unit must be capable of maintaining the required cold fill pressure in the heating water system. The cold fill pressure must be controlled by means of a pressure transducer, as indicated. The unit must have duplicate pumps. Duplicate pumps must have controls enabling manual selection of duty pump and auto-changeover in the event of duty pump failure. BMS Modbus/BACnet Interface for monitoring and alarm integration shall be provided. The unit shall have the following functionality/performance characteristics

- Modbus & BACnet communication outputs
- Simple, security coded user interface
- Event logging
- Low water sensor
- Durable powder coated enclosure
- Duty/stand-by pumps with auto-changeover
- WRAS approved components
- Max operating system temperature 85°C
- Ambient operational temperature up to 40°C
- Low/high water alarm
- Hours run/pump activation counter/alarm logging
- BMS interface for above inclusive of leak alarm/High and low pressure alarm
-

5.2.3 The equipment must be connected to the system return main on the suction side of the main circulating pumps. A lockshield valve must be installed on the line prior to the system connection. A drain cock and union must be installed between the fill unit and the lockshield valve. In addition, each expansion vessel must be fitted with a drain cock and a lockshield or lockable isolating valve. The pipeline from the expansion vessel to the system connection must not exert any strain on the fill unit and must not be insulated. An anti-gravity loop of minimum height 2m must be installed.

5.2.4 A 15 mm. bore cold water pipe shall be taken from the mains water pipe and connected to the filler unit. The pipe shall be insulated as specified for heating pipework.

5.2.5 The autofill unit should be capable of maintaining the system pressure of 2 Bar at a boiler load (combined) of 100kW and an estimated static height of 35 metres. The unit shall be of Wilo or Grundfos manufacture.

5.3 EXPANSION VESSELS (LTHW)

5.3.1 The vessels shall be sized to suit the duty of the system and maintaining a vessel acceptance rate between 25-40% for the maximum system operating pressure allowed. The contractor shall provide a 32mm valved and blanked connection for a future additional expansion vessel of similar size.

5.4 THERMOMETERS

5.4.1 Approved type 100 mm. dial type bi-metal thermometers graduated in degs. Celsius shall be supplied and fixed in the main flow and return pipes in the boiler room. The scale of the thermometers shall be graduated 0 degs. to 120 degs. C. The stem shall be not less than 60 mm. and the correct thermometer pocket shall be provided.

5.5 VALVE CHARTS

5.5.1 All valves shall be labelled as specified and reference charts shall be provided indicating the location and function of each valve. These charts shall be laminated and mounted in their respective locations.

5.6 PRESSURISATION UNIT(S)

5.6.1 The Mechanical Contractor must include for the supply and installation of a packaged pressurisation unit. The unit must be supplied pre-wired and pre-piped and must consist of the following equipment:

5.6.2 2 No. Microprocessor controlled packaged auto fill makeup unit complete with dual pumps on duty/standby operation to suit a cold fill pressure of 1.0 – 3.0 bar. Unit c/w break tank with ball valve array, pump control pressure transducer, digital LED pressure display, non-return valve, all pre-piped and mounted in a powder coated sheet steel tamper-proof cabinet.

5.6.3 Fully automatic built-in control panel incorporating microprocessor controller for pump operation, high/low pressure protection, low water level.

5.6.4 The unit must be complete with a volt-free contact and alarm buzzer and lights on board to give high pressure, low pressure, and pump 1-2 fault and low water level contacts.

5.6.5 The Mechanical Contractor must include for the commissioning of the unit by the manufacturers and for supplying the Electrical Contractor with all the necessary wiring diagrams and details.

5.6.6 Pressurisation units and their controls must be arranged to fail safe.

5.6.7 Provision must be made for quick-filling the system in parallel with the make-up water system provided for normal service.

5.6.8 Prior to placing an order, the Mechanical Contractor must submit full details of the proposed equipment to the Engineer for approval.

5.6.9 The automatic fill unit(s) must be of proprietary packaged construction mounted on a common base-plate, comprising break tank, foot valve, pump(s), hydraulic accumulator, and all necessary controls, safety devices and power connections.

5.6.10 The unit must be capable of maintaining the required cold fill pressure in the heating water system. The cold fill pressure must be controlled by means of a pressure regulating valve or a system pressure switch, as indicated. The pressure regulating valve must be adjustable to maintain the required system pressure.

5.6.11 The unit must have duplicate pumps as indicated. Duplicate pumps must have controls enabling manual selection of duty pump and auto-changeover in the event of duty pump failure. BMS link-up facilities must be provided as indicated.

5.6.12 Expansion must be accommodated in a sealed diaphragm expansion vessel(s), suitable for working pressure of 8 bar unless otherwise indicated, with EPDM rubber membrane. Diaphragms must be replaceable. Vessel must be not less than 200 litres total capacity.

5.6.13 The equipment must be connected to the system return main on the suction side of the main circulating pumps. A lockshield valve must be installed on the line prior to the system connection. A drain cock and union must be installed between the fill unit and the lockshield valve. In addition, each expansion vessel must be fitted with a drain cock and a lockshield or lockable isolating valve. The pipeline from the expansion vessel to the system connection must not exert any strain on the fill unit and must not be insulated. An anti-gravity loop of minimum height 2m must be installed.

5.7 CIRCULATING PUMPS

5.7.1 The Mechanical Contractor must include for the supply and installation of heating circulating pumps as scheduled in Mechanical Services Schedule Document MS02 & indicated on heating schematic drawing CCT-JVT-CH-XX-DR-M-5961.

5.7.2 All pumps supplied under the contract shall conform to the latest EU ErP (Energy related Products)/EuP (Energy using Products) Directive 2017 efficiency requirements.

5.7.3 Values of the resistance to fluid flow indicated are based in Mechanical Services Schedule Document MS02 on the Engineer's design drawings and specified equipment. Any variations from the development of the Mechanical Contractor's co-ordination and working drawings caused by changes to equipment, components, fittings, pipework layouts, pipework sizes, etc. must be brought to the attention of the Engineer.

5.7.4 The Mechanical Contractor must ensure that the pumps provided are capable of delivering the required fluid flow when operating against the actual total system resistance. The actual system residual pressure shall be measured by the mechanical contractor.

5.7.5 Unless otherwise indicated, pump duties must be achieved with an impeller shaft speed not exceeding 1450 RPM, or by means of infinitely variable speed control drives where specified.

5.7.6 Pumps must be installed in accordance with the manufacturer's recommendations and must comply with the requirements of IS/EN 60335-2-51, BS 4082: 1969 and BS 5257: 1975 as applicable, or equivalent. Pumps must be 'type' tested in accordance with IS EN ISO 9906:2000 and IS EN ISO 5198:1999. Pump curves must be submitted to indicate performance under all likely operating conditions.

5.7.7 Flexible connections must be provided on the suction and discharge side of all pumps with end connections over 50 mm and elsewhere as indicated.

5.7.8 Each pump must be installed with isolating valves on the inlet and outlet connections. Unless otherwise indicated, a strainer must be fitted on the inlet connection. Where duty and standby pumps are installed a suitable spring return type check valve must be fitted on the discharge of each pump. Where standby pumps are indicated with automatic change-over, the change-over must be initiated and verified by means of flow sensing devices or within pump control logic integral in the pump set.

5.7.9 Pressure gauges must 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.

5.7.10 Centrifugal pumps must be electrically driven by glandless or TEFC squirrel cage motors to IEC standards. Electric motors must comply with the relevant Section of this Specification.

Type A – Canned Rotor Pumps Variable Speed

5.7.11 The pump and motor must form an integral unit without a shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid. Attention to be focused on using as few materials as possible, and the use of materials that might cause problems in connection with disposal must not be used.

5.7.12 The pump must be capable of automatically adjusting to the system requirements via the integrated variable speed drive.

5.7.13 The pump terminal box must have light fields indicating the setpoint, operating pressure, operating mode, pump status, fault status and must be capable of communication with a hand held remote control.

The pump must have an energy rating "**A**"

The pumps are characterised by;

- Controller integrated in the terminal box
- Control panel on the terminal box
- Terminal box prepared for optional modules
- Integrated differential-pressure and temperature detection
- Cast-iron, stainless-steel or bronze or pump housing
- Twin-head versions
- No external motor protection required.

5.7.14 The **single-phase** motor to be a 2, 4- or 8-pole, synchronous, permanent-magnet motor (PM motor). This motor type is characterised by higher efficiency than a conventional asynchronous squirrel-cage motor. Pump speed is controlled by an integrated frequency converter. The motor is to be energy "**A**" rated. The pump must incorporate a thermal protection device to protect against slow overloading and blocking (IEC 34-11:TP211)

5.7.15 **Single-phase** motor to be a 2-pole, asynchronous squirrel-cage motor with radio noise filter to VDE 0875. The terminal box and the motor-pump unit must be tested in accordance with VDE 0700.

5.7.16 The terminal box must incorporate the pump controller. The pump speed is to be calculated via a built-in induction coil on the stator winding.

5.7.17 **Three-phase** motor to be a 2-pole, asynchronous squirrel-cage motor with integrated frequency converter. A differential-pressure and temperature sensor forms an integral unit. The sensor is located inside the pump housing in a channel between suction and discharge sides. Twin-head pumps must have two sensors.

The following functions must be available as standard in the pumps.

- **Auto Adapt** - During operation the pump automatically reduces the factory set setpoint and adjusts to the actual system characteristics.

- **Constant Pressure -** The pump can constantly adjust to keep the differential pressure constant.

- **Proportional Pressure -** The pump differential head is changed continuously in proportion to the flow.

- **Constant Curve** - The pump can be set to operate in a constant curve. This curve must be infinitely variable.

- **Max or Min Curve** - The pump can be set to its maximum or minimum curve via digital input.

- **Analog Input** - The setpoint can be changed via an external
- analog input 0-10V

- **Automatic Night time Setting -** The pump switches to a night time setting when the pump temperature sensor registers a temperature drop in the flow pipe of 10 – 15°C over a 2 hour period. The pump must revert to normal operation when the temperature increases by 10° C.

- **Temperature Influence -** The pump head modulates in response to a change in the pumped liquid temperature.

- **External Start Stop** - Via external potential free contacts.

- **Signal Relay** - Must be programmable for operation on fault, pump operating or pump ready.

- **Fault Signal** - Common fault indication via red light on the pump and external digital output. Fault causes to be available on a hand held remote controller.

Twin Head pumps must have the following extra functions:

- **Alternating Operation** - The pumps operate as duty standby pumps respectively. Automatic change over takes place every 24 hours. If the duty pump cuts out due to fault, the standby pump is automatically started. During change over both pumps must run for a short period to ensure a low noise change over.

- **Standby Operation** - The pumps operate as duty standby operation. If the duty pump cuts out the standby pump must automatically start.

- **Single Pump Operation** - The pumps can be set to operate independently of each other.

The following inputs and outputs must be available as standard:

Material specification

- Terminal box Aluminium/composite
- Stator housing Aluminium AlSi 10Cu2

- O-rings EPDM rubber
- Outer bearing ring Aluminium oxide Al2O3
- Rotor can Stainless steel 1.4301 or 1.4401
- Shaft Stainless steel or tungsten carbide or
- aluminium oxide
- Thrust bearing Carbon MY 106
- Bearing plate Stainless steel 1.4301
- Inner bearing ring Aluminium oxide Al2O3 or Silicium carbide SiO
- Impeller Stainless steel or composite
- Pump housing Cast iron EN-GJL150/-200/-250 bronze or stainless steel9
- Differential-pressure and temperature sensor Composite PES

Surface treatment

- The pumps are wet-varnished. Colour:
- Threaded pump connections to ISO 228/1.
- Flange dimensions to ISO 7005-2/BS4504.

Type B - In Line Pumps Glanded - Single & Twin Head

5.7.18 The pumps must be single-stage, centrifugal volute pumps with in line suction and discharge ports and vertical shafts.

5.7.19 Suction and discharge flanges to PN 16 in accordance to EN 1092-2. Pumps to be in line with a totally enclosed fan-cooled standard motor with main dimensions to IEC and DIN standards

5.7.20 Mechanical shaft seal to have dimensions in accordance to EN 12756. All pumps to be dynamically balanced according to ISO 1940 class 6.3.and impellers are hydraulically balanced.

5.7.21 Pumps are of the back pull-out design enabling removal and dismantling of the motor and impeller without disturbing the pump housing or pipework.

5.7.22 Twin head pumps must have a non return valve in the common discharge port.

Material specification

- Pump housing Cast iron EN-GJL-250 EN-JL 1040
- Impeller Cast iron EN-GJL-200, bronze CuSn5Zn5Pb & stainless steel
- EN-JL 10302.1096.01
- Shaft/sleeve coupling Steel/stainless steel
- Motor stool/pump head Cast iron EN-GJL-250 EN-JL 1040
- Secondary seals EPDM
- Rotating seal face Metal-impregnated carbon, silicon carbide
- Stationary seat Silicon carbide

High-efficiency motors

5.7.23 Pumps to be fitted with high-efficiency motors (EFF 1) from 1.1 to 90 kW as defined by CEMEP (European Committee of Manufacturers of Electrical Machines and Power Electronics).

Surface treatment

All cast iron parts of close coupled pumps to be electro coated.
Electro-coating to include:

1. Alkaline cleaning
2. Pre-treatment with zinc phosphate coating
3. Cathodic electro-coating (epoxy)
4. Curing of paint film at 200-250°C.

Pump housing

5.7.24 The volute type pump housing is to be manufactured of cast iron and to have in line suction and discharge ports. Flange connection dimensions are in accordance with EN 1092-2. The bottom of the pump housing incorporates a drain plug. The discharge port has a pressure gauge tapping.

Motor stool and cover

5.7.25 The cover is provided with a manual air vent screw for the venting of the pump housing and the shaft seal chamber. An O-ring forms the seal between cover and pump housing. Coupling guards are fitted to the motor stool.

The mounting designations of motors for close coupled pumps are as follows:

- IM B5: Up to and including frame size 132.
- IM B 35: As from frame size 160 and upwards.

5.7.26 The flange size of the motor stool is according to IEC 60034.

Shaft/coupling

5.7.27 The pump shaft and coupling must be constructed from one piece of stainless steel. The motor shaft must fit into the pump shaft and be secures by two set screws.

Coupling guard

5.7.28 Stainless Steel 1.4301

Impeller

5.7.29 The impeller to be manufactured from cast iron, bronze or stainless steel. The impeller is closed and has double-curved blades with smooth surfaces ensuring high efficiency. All impellers to be dynamically and hydraulically balanced. The hydraulic balancing to compensate for axial thrust.

5.7.30 The direction of rotation of the impeller is clockwise when viewed from the motor fan. Cast iron impellers must be electrocuted.

Shaft seal

5.7.31 The shaft seal to be unbalanced, mechanical shaft seal with dimensions according to EN 12756. The seal must be bellows type seal with carbon/silicon carbide seal faces and EPDM O Rings.

Type C - Variable In Line Pumps Glanded - Single & Twin Head

5.7.32 The pumps must be constructed as detailed above but fitted with a motor with an integrated variable speed drive. The pumps must incorporate a PI Controller and differential pressure transmitters enabling automatic control of the differential head across the pump. The motor must be fitted with a control panel where the set point can be adjusted and the control mode of the pump selected. The must also have the facility for communication with a hand held remote control.

Motor Protection

5.7.33 The motors must incorporate thermal protection against slow overloading and blocking (IEC 34-11: TP211) No external motor protection is required.

5.7.34 The motor must be protected against over voltage by means of built in varistors between the phases and between phases and earth.

5.7.35 The motors must be suitable for a power supply of 3 x 380-480V +/- 10% 50/60 Hz PE.

5.7.36 The number of start/stops via the mains voltage must not exceed 4 times per hour.

5.7.37 If the pump is connected to an installation where an earth leakage circuit breaker is used, this circuit breaker must be of the type Which is suitable for handling leakage currents and cutting in with short pulse shaped leakage. Which trips out when alternating fault currents and fault currents with DC content .i.e. pulsating DC and smooth DC fault currents occur.

5.7.38 The circuit breaker must be marked with the following symbols:



Other connections

5.7.39 All control input and output terminals must be internally separated from the mains conducting parts by reinforced insulation and galvanically separated from other circuits.

5.7.40 All control terminals must be supplied by protective extra low voltage (PELV), ensuring protection against electric shock. It must be possible to remove the terminals blocks to facilitate wiring and then replace the wired unit.

5.7.41 All galvianically safe separation must fulfil the requirements for reinforced insulation inducing creepage distances and clearances specified in EN 60 335.

5.7.42 A selector switch must allow the pump to be set in alternating or stand by modes.

Control Panel.

5.7.43 The pump must have a control panel on the terminal box allowing settings to be made on the pump and information to be obtained from the pump.

5.7.44 There must be a light field indicating the set point of the pump. There must be buttons to increase or decrease the set point. There must be an indication of operating mode i.e proportional or constant pressure. There must be a facility on the control panel to change the control modes. There must be red and green fault and operating lights and an indicating of connection to an external controller.

5.7.45 It must be possible to communicate with the controller by means of a hand held controller with the option of a paper print out of all information.

5.7.46 It must also be possible to connect a PC to the pump for service and advanced setting of the pump including data logging.

Functions

The following functions must be available as standard in the pumps.

- **Constant Pressure -** The pump can constantly adjust to keep the differential pressure constant.
- **Proportional Pressure -** The pump differential head is changed continuously in proportion to the flow.
- **Constant Curve** - The pump can be set to operate in a constant curve. This curve must be infinitely variable.
- **Max or Min Curve -** The pump can be set to its maximum or minimum curve via digital input.
- **Analog Input -** The setpoint can be changed via an external analog input 0-10V
- **Temperature Influence -** The pump head modulates in response to a change in the pumped liquid temperature.
- **External Start Stop -** Via external potential free contacts.
- **Signal Relay. -** Must be programmable for operation on fault, pump operating or pump ready. The relay must have a choice of configuration Normally open or Normally closed.
- **Fault Signal -** Common fault indication via red light on the pump and external digital output. Fault causes to be available on a hand held remote controller.

Twin Head pumps must have the following extra functions:

- **Alternating Operation** - The pumps operate as duty standby pumps respectively. Automatic change over takes place every 24 hours. If the duty pump cuts out due to fault, the standby pump is automatically started. During change over both pumps must run for a short period to ensure a low noise change over.

- **Standby Operation -** The pumps operate as duty standby operation. If the duty pump cuts out the standby pump must automatically start.

- **Single Pump Operation** - The pumps can be set to operate independently of each other.

5.8 MOTORISED CONTROL VALVES

The Mechanical specialist shall include for the supply and installation of a motorised on/off valve after the pump on each of the heating circuits. Each of the valves shall be wired to open when the pumps start and close when the pumps are switched off. The valves shall be of an approved manufactured and shall be sized to match the bore of flow pipework on each circuit as indicated on the drawings.

5.9 CONTROL VALVES

Control valves in the boiler house for L.P.H.W. shall be of the lever action type of heavy gunmetal construction fullway gate pattern of approved make and design. In the case of all valves 50 mm. bore and under they shall be constructed entirely of gunmetal while valves of 65 mm. bore and over shall have cast iron body and gunmetal working parts.

All valves shall be designed so as to close tightly on their seats and shall not drag or score the seating in opening or closing. Union or flanged connections shall be provided for all valves. All control valves shall be insulated as specified. Handles on flow and return circuit shall be fitted with an engraved brass indicating the circuits controlled. A laminated valve chart shall be supplied and mounted on the wall on the boiler room indicating the circuits controlled. Before final printing this shall be approved by the Engineers.

Valves of the type and size indicated on the schematic shall be supplied and fitted in the boiler room. Valves on L.P.H.W. circuits shall be of an approved manufactured.

5.10 DE-AERATOR AND DIRT SEPERATOR

The Contractor shall include for the supply and installation of a micro bubble de-aerator and dirt separator pipeline strainers on the main heating flow line in each of the heating systems as indicated on the schematics.

5.11 DISCONNECTION OF PIPES

A sufficient number of unions, flanges and other fittings shall be used to enable any part of piping to be disconnected and removed without undue disturbance.

5.12 THERMOMETERS

2 No. approved type 100 mm. dial type bi-metal thermometer graduated in degs. Celsius shall be supplied and fixed in the main flow and return pipes in the boiler room. The scale of the thermometers shall be graduated 0 to 120^{0}C. The stem shall be not less than 60 mm. and the correct thermometer pocket shall be provided.

5.13 DRAIN COCKS

Gunmetal drain cocks with hose unions shall be fitted on the flow and return piping to

each circuit in the positions indicated by the Engineers on site.

5.14 AUTOMATIC CONTROLS

The Mechanical specialist shall include for the supply and installation of automatic temperature control equipment to adjust the output of the new heating system according to outside weather conditions. The equipment shall be manufactured by an approved supplier and shall consist of the following for each boiler room:

1 No. Outside pilot stat to be mounted in a position to be approved by the Engineers.
1 No. Immersion thermostat to be fitted into the primary flow to the heating circuits.
The above equipment shall be controlled by the BMS front end PC in addition to the BMS module located in the control panel
1 No. Frost thermostat Set at + 5^0C to control pumps
1 No. Immersion frost thermostat set at 2^0C to operate the ASHP

5.15 SUPERVISORY SERVICE AND COMMISIONING OF CONTROLS

The Mechanical specialist shall include in their tender for the cost of the BMS System supervisory service. The service is to apply to all items of BMS equipment being used under this contract.

The service to be provided shall consist briefly of the following:

Advice on the operation, positioning, wiring and setting of control equipment.
Site Supervision when controls are being installed.
Commissioning of control system.
Service brochure on equipment installed.
Instructing customers representatives on the operation of the system.

The Mechanical specialist shall indicate the cost of this service in the Summary of Tender attached to the specification. The Commissioning Certificate shall be submitted to the Engineers prior to Practical Completion.

5.16 PLANT ROOM CONTROL PANEL

The Mechanical specialist shall include for the supply only of a pre-wired plantroom control panel as detailed in the **relevant Section 9** "Automatic Controls" of this Specification which they shall hand over to the Electrical specialist.

Sheet steel enclosure.
Main Switchfuse 63A T.P. & N.
M.C.B. Board
Control relays
Contactors for pumps, motorised valves, boilers
BMS modules UCC 4 / UCC 16 or equivalent.
Switches for ASHP, pumps
Terminals for remote over-ride panel
Optimum start facility

The entire unit shall be as manufactured by the specialist BMS supplier. The Mechanical specialist shall provide details of pump over-loads to the specialist BMS supplier to ensure that the contactors provide adequate protection to the pumps.

On completion the panel shall be labelled showing each item controlled. Rigid engraved plastic labels shall be fitted to the front of the control panel to the approval of the Engineers.

5.17 PAINTING

All insulated pipes in the boiler room shall be painted two coats of approved heatresisting paint in colours approved of by the Engineers. All other metal work in the boiler room shall be thoroughly cleaned and given two coats of approved colour paint

5.18 ELECTRIC WIRING

No electric wiring shall be carried out under this contract. The Mechanical specialist shall be responsible for handing over wiring diagrams of all equipment supplied to the Electrical specialist.

5.19 BALANCING OF CIRCUITS

After completion of the installation, the Mechanical specialist shall carry out all the necessary balancing and regulating of the system so as to ensure that all systems etc. heat evenly. All valves in the boiler house shall be fitted with engraved rigid plastic discs indicating the circuits controlled and a printed heat sealed valve chart in a glazed metal frame shall be provided and securely fixed to the wall of the boiler room.

5.20 TEST

After completion of the installation the whole of the pipework shall be subjected to a hydraulic test to pressure of 7 bar. The ends of all supplies to fixtures shall be blanked off before the test is carried out. Brackets securing piping shall be loosened up to allow for straining of the pipe while under pressure. The system shall be subject to the test for a period of not less than 24 hours and shall remain drop tight for the duration of the test.

After a satisfactory test the whole of the system shall be thoroughly flushed out and sealed off preparatory to filling before being put into commission. The Mechanical specialist shall service notice on the Engineers prior to carrying out the test. At least fourteen days' notice shall be required.

5.21 HANDOVER AND DEMONSTRATION

On completion of the contract, all literature supplied with the boilers room plant shall be bound together and handed over to the Main Contractor. A valve chart as previously specified shall be mounted in each boiler room and the Mechanical specialist shall instruct the client regarding the operation, maintenance and cleaning of the plant.

6 SOILS AND WASTES – ABOVE GROUND (ELEMENT 52)

The works covered in this section shall comprise the following:

1 Complete installation of all the above ground soils and waste pipework from W.C's, wash hand basins, sinks, showers etc., including final connections and waste traps.
2 The Contractor shall include for all fire collars on soils and wastes pipework where they pass through fire compartments i.e. floors/walls.
3 The Contractor shall include for the supply and installation of rigid foil backed fibreglass to a thickness of 50mm for all concealed soil vent stacks and main horizontal runs.
4 The Contractor shall include for final connections to all white goods including washing machines and kitchen equipment.

6.1.1 All work shall be carried out to the exact requirements of the relevant Local Authority, the specification and drawings.

STANDARDS	
STANDARD	**TITLE**
BS. 5750 Part 2, 1990	Specification for Production and Installation
B.S. 4514 1983	Specification for Unplasticised P.V.C.
B.S. 5255: 1989	Specification for Plastics waste pipe and fittings.
B.S. 5627 1984	Specification for Plastics connectors.
B.S. 5254 1976	Specification for Polypropylene waste pipe and fittings.
B.S. 3943 1979	Specification for Plastics waste traps.
B.S. 6209 1992	Specification for Solvent cement.
B.S. 2492 1990	Ring seals.

6.1.2 All pipework and fittings to be installed in accordance with B.S EN 12056 and B.S. 5572, 1978, Code of Practice for sanitary pipework.

6.2 PIPEWORK (WCs-SOIL)

6.2.1 All soil pipework shall be P.V.C. to B.S. 45414, 2001 including all bends, branches, Boss branches and adapters. All internal pipe runs shall be solvent welded jointed with the exception of mechanical joints for fixture connection, access/rodding access points etc. Refer also to drawings. All other pipework connections shall be ring seal joints allowing an expansion gap where necessary. The requirement of the supplier regarding installation of ring seal joints and solvent cement shall be clearly and fully adhered to.

6.2.2 The Contactor shall include for all pipework fittings, cleaning eyes, access points etc. All vents from soil system shall be carried to 3000mm above roof level/900mm above roof level screens, terminating in a suitable vent cap and bird guard. The Contractor shall provide all necessary weathering collars and aprons to the manufacturer's specification. The Contractor shall include for all pipework supports to comply with B.S. 5372 and the manufacturer's requirements.

6.2.3 The Contractor shall demonstrate to the Engineers the stability and rigidity of the entire system prior to testing.

6.2.4 Adequate provision for rodding and cleaning shall be provided on all pipe runs whether indicated or not.

6.2.5 Pipework support shall be pipe support system in zinc electro plated mild steel system.

6.2.6 Unless otherwise indicated, soils and wastes pipework in basement areas and areas where it may be subject to damage shall be socketless cast iron to BS EN 87: 1999.

6.2.7 Unless otherwise indicated, soils and wastes pipework running through occupied spaces shall be insulated for acoustic purposes.

6.2.8 All pipework 40mm and above passing through fire rated structures shall be fitted with intumescent fire collars complete with base frame. Intumescent fire wraps shall not be accepted.

6.2.9 All waste pipework (appliance/fixture branch runs) shall be M.U.P.V.C. waste system to B.S. 5255, 1989 including all bends, branches, Boss branches, adapters, etc. M.U.P.V.C. (modified unplasticised polyvinal chloride). All internal runs shall be solvent welded jointed. Refer to drawings. All pipework shall be ran concealed where possible. The requirement of the system manufacturers shall be adhered to regarding the installation of solvent welding joints.

6.2.10 All waste pipework and fittings up to 55 mm dia. shall comply with BS EN 1329-1:2000, MuPVC pipework.

6.2.11 Unless otherwise indicated, soils and wastes pipework in basement areas and areas where it may be subject to damage shall be socketless cast iron to BS EN 87: 1999.

6.2.12 Unless otherwise indicated, soils and wastes pipework running through occupied spaces shall be insulated for acoustic purposes.

6.2.13 All pipework 40mm and above passing through fire rated structures shall be fitted with intumescent fire collars.

6.2.14 Solvent cements for jointing of M.U.P.V.C. shall conform to B.S. 6209, 1982.

6.2.15 The Contractor shall include for all pipework fittings, cleaning doors, access points, etc. All vents shall be extended to roof level and shall terminate 600mm above roof level terminating in vent cap and Birdguard. The Contractor shall provide all necessary weathering collars and aprons to the manufacturer's specification. The Contractor shall include for all pipework supports to comply with B.S. 5572.

6.2.16 The Contractor shall demonstrate to the Engineers the stability and rigidity of the entire system prior to testing.

6.2.17 Adequate provision for rodding and cleaning shall be provided on all pipe runs whether indicated or not.

6.2.18 All cold water storage tank overflows and W.C. overflow pipework where they discharge to atmosphere to be complete with Legionella arrestors.

6.2.19 The Contractor shall clearly label with typed indicators the service and termination point i.e. level, grid reference etc. and shall cover this label with adhesive plastic to enable future Tenants to easily identify the service.

6.3 JOINTING

6.3.1 PVC pipework and fittings shall have neoprene 'O' ring joints. Refer to above RE WC-Soil runs- to be solvent welded.

6.3.2 MuPVC waste pipework and fittings shall have solvent welded joints except at expansion joints or boss connections to discharge stacks (external), which shall be jointed using 'O' rings.

6.3.3 Joints on socketless cast iron pipework shall be flexible mechanical type to BS EN 877: 1999.

6.3.4 Jointing to WC pans shall be made using patent connectors.

6.3.5 All jointing shall comply with the manufacturer's instructions.

6.3.6 Where applicable on a single stack system a collar boss may be used on the vertical stack to take additional discharge pipes.

6.4 EXPANSION

6.4.1 The Contractor shall make sufficient allowance for thermal expansion during installation of pipework. Where expansion couplings are used, support brackets shall be positioned on each side of the coupling.

6.5 SUPPORTS

6.5.1 Supports shall be of proprietary manufacture and shall be provided at the following maximum intervals and at either side of bends:

Pipe Material	Pipe Dia. (mm)	Vertical Pipe (m)	Low Gradient Pipe (m)
MuPVC	32-40	1.2	0.5
	50	1.2	0.6
uPVC	32-40	1.2	0.5
	50	1.2	0.6

	75-100	1.8	0.9
	150	1.8	1.2
Cast Iron	75-100	1.8	0.9
	150	1.8	1.2

6.5.2 The Contractor shall ensure that bracing shall be used where necessary, i.e. at the base of stacks, where pipework is liable to suffer impact damage and generally where pipework is required to be stabilised.

6.6 WASTE TRAPS

6.6.1 The Contractor shall supply and install all waste traps to toilet areas as detailed on the drawings.

6.6.2 All traps shall be of polypropylene manufacture to B.S. 4943, 1979.

6.7 CLEANING EYES

6.7.1 Cleaning eyes shall be fitted on all bends of the uPVC, M.U. PVC and Vulcathene piping systems. The cleaning eyes shall be of approved design and shall not be less than the diameter of the pipe to which it is fitted. Cleaning eyes shall be fitted on all branch runs and on all stacks per floor level.

6.8 RODDING EYES

6.8.1 Rodding eyes shall be provided on the waste floats for the wash hand basins and W/C's.

6.9 VENTS AND COWLS

6.9.1 All ventilated discharge stacks throughout the building shall be terminated with air admittance valves in accordance with paragraph 1.2.3.8. of TGD-H.

6.10 SANITARY FIXTURES

6.10.1 All sanitary fixtures including sinks, wash hand basins, W.C. units, urinals, etc. shall be supplied and fixed by others. Final connections shall be by the Mechanical Contractor.

6.11 TRAPS

6.11.1 All traps shall be constructed of polypropylene and shall be of the deep seal, re-sealing type with a minimum seal depth of 75 mm.

6.11.2 In general tubular traps shall be used on all sinks, wash hand basins and urinals. Bottle traps may be used on wash hand basins where the trap is exposed.

6.12 TESTING

Pipework Test:

6.12.1 As soon as practicable, from floor to floor as work proceeds and prior to closing of shafts, all soils and wastes pipework shall be air tested to a pressure of 100 mm W.G. held constant for a period of not less than 5 minutes.

6.12.2 All soils and wastes, overflows and drains shall be tested in accordance with B.S. 5572, 1978.

6.12.3 Temporarily seal open ends of pipework with plugs.

6.12.4 Connect 'U' tube with water gauge and air pump to the pipework by a plug or through the trap of an appliance.

6.12.5 Allow a period of temperature stabilisation, after which the pressure of 50mm is to be maintained without loss for not less than 5 minutes.

Siphonage and Back Pressure Testing:

6.12.6 Siphonage and Back Pressure Testing to be carried out in accordance with BS 5572.

6.12.7 Each appliance must be individually tested for self-siphonage and induced siphonage and back pressure by discharging a number of appliances simultaneously on each stack.

6.13 INTUMESCENT COLLARS

6.13.1 The Contractor shall include for the supply and installation of intumescent collars on all soils and wastes pipework systems where the pipework passes from fire compartment to fire compartment on horizontal and vertical runs.

6.13.2 All fire collars shall be in accordance with B.S. 476, Part 20, 1987 and shall be installed strictly in accordance with manufactures requirements. All collars shall be suitable for bolting and sealing to the slab and be complete with a metal frame.

6.14 CO-ORDINATION

6.14.1 It shall be the responsibility of this Contractor to co-ordinate the installation of the soils and wastes pipework in conjunction with all other services. They shall ensure that all opes line up vertically and are fully co-ordinated with drainage from manholes etc.

6.15 FLOOR GULLIES

6.15.1 The Contractor is to allow for the supply and installation of 500 x 500 stainless steel linear floor gullies as indicated on the drawings.

7 HOT, COLD, MAINS WATER INSTALLATION (ELEMENT 53)

The works covered in this section shall comprise the following:

1 Complete installation of hot, cold, and mains water pipework installations including the supply and installation of/connection to water heaters
2 Complete installation of 2no. cold water storage tanks.
3 Complete installation of fire extinguishers.
4 Complete water systems testing and commissioning.

7.1.1 All work shall be carried out to the exact requirements of the relevant Local Authority, the specification and drawings.

7.2 ELECTRIC WATER HEATERS

Electric water heaters shall conform to IS EN 60335-2003-A14-2010 and shall be supplied and installed in accordance with manufacturer's instructions. They shall be of the unvented pressure type complete with thermostatic control, a high limit cut-out 'stat (manual reset), expansion vessel, cold inlet, hot outlet, safety valve and drain, piped to nearest suitable discharge point. Unless otherwise indicated, electric water heaters shall be fed by a cold water supply from the cold water storage tank(s) separate to the cold water service. The Contractor shall ensure that the taps being supplied by the Main Contractor are suitable for use with the type of water heater.

- Available in 5 litre and 10 litre.
- High density polyurethane foam insulation which reduces radiant heat loss, reduces energy consumption and ensures high energy efficiency.
- Exclusive dry powder porcelain enamel tank lining delivering twice the corrosion resistance of ordinary glass lining.
- Fitted with heavy duty seamless bolt – on square flange type heating elements which are more durable and efficient.
- Fitted with premium protective magnesium anode rod which equalises aggressive water action and provides extra protection against corrosion.
- External thermostat control allows adjustment to preferred water temperature.
- Fitted with limiting device to provide protection of overheating.
- Supplied with expansion relief valve calibrated at 6 Bar
- Wall or floor mounting
- Supplied with wall brackets.

Capacity of Water Heater	Number of Basins
5 litres	1 – 2
10 litres	2 – 3

Max heat up time
15 litres – 32 minutes

7.3 THERMOSTATIC MIXING VALVES

The mechanical specialist shall supply and fit an approved TMV3 point of use thermostatic mixing valve sized in accordance of the application to each WHB and sink. The valve should be suitable for the application and capable of a constant maintained temperature to the outlets of washbasins, sinks, showers, and bidet

appliances. The valves shall reduce the temperature to 43oC by blending full temperature hot water with cold for safe use. The valve should be of DZR brass body and should have a pre set lockable tamperproof setting preventing unauthorised temperature adjustment. The thermostatic valve should have integral check valves and strainers. The mechanical specialist shall also include for the commissioning of these valves.

The thermostatic mixing valve shall have WRAS approval and comply with EN 1111 and EN1287 standards. The fitting should be supplied with flat faced union connectors terminating in compression fittings to ensure the ease for maintenance and removal of the valve if required. The mechanical specialist should ensure that isolation valves are fitted.

The valves shall be located behind accessible panels above wash hand basins.

Each new wash hand basin shall have a Thermostatic Mixing Valve Installed.

7.4 DOMESTIC WATER SYSTEMS

7.4.1 The HWS system shall be installed in accordance with the requirements of CIBSE TM13 and BS 6700 regulations/guidelines.

7.5 POTABLE 'DRINKING' WATER SUPPLY

7.5.1 The Contractor shall run mains water piping to each of the points marked on the drawing. A rigid plastic plate with the words "DRINKING" engraved thereon shall be fixed on the wall adjacent to each drinking water fixture.

7.6 PORTABLE EXTINGUISHERS

7.6.1 Portable extinguishers shall be provided as determined by specialist, and shall conform to IS EN 3-3: 1994. The information outlined in this section is provided for guidance purposes only. The Mechanical Contractor has full design, supply and fitting & testing responsibility for the full extent of portable fire extinguishers for the building. The mechanical contractor shall engage a specialist to carry out the portable extinguisher design in line with relevant building regulations, IS and EN standards. They shall be supplied complete with wall mounting brackets and all necessary fixing bolts.

7.6.2 Portable extinguishers shall be exclusively designed for operation by seize and squeeze release. No other method of release shall be acceptable.

7.6.3 Portable extinguishers shall be distributed throughout the building and shall be bracket-mounted with the horizontal centreline located not more than 1.5 metres above floor level. Each mounting bracket shall be painted with a coloured coding patch to identify the type of extinguisher fitted - red for water, blue for dry powder, black for CO2 and cream for foam in accordance with SI No.132 of 1995 'Safety, Health and Welfare at Work (Sign) Regulations 1995'.

7.6.4 The Contractor shall ensure that all portable extinguishers are sited in areas remote from heat sources such as radiant or convector heaters, steam pipes etc. which might otherwise combine to produce a hazardous environment.

7.6.5 The Contractor shall arrange with the supplier to discharge one of each type of fire extinguisher selected at random by the Engineer. Should a fire extinguisher fail to operate in accordance with the relevant BS, it shall be replaced, and the Engineer may select further fire extinguishers for testing until satisfied with the installation. All costs associated with testing, replacing cartridges and the replacement of fire extinguishers shall be included by the Contractor.

7.6.6 Extinguishers shall be located in conspicuous positions on brackets or stands where they will be readily seen by persons following an escape route.

7.6.7 All plant rooms shall be provided with 6kg Class C Extinguishers in accordance with IS291 in addition to 1no. 2kg Class A.

7.7 STERILISATION OF THE COMPLETED INSTALLATION

7.7.1 The Contractor shall include in their tender for sterilising the entire new water services system twice; once at substantial completion and the second time prior to being put into operation. This sterilisation shall be carried out by an accredited specialist under the mechanical works contract and certified by same as sterilised/chlorinated to the requirements of BS 6700.

7.7.2 Before sterilisation all pipework and storage tanks should be flushed out to remove dirty water, debris, etc. The main storage tank should then be filled with water and sufficient chemicals should be used to give the water a dose of 50 milligrams of chlorine per litre of water. The mains supply valve should then be closed. Taps should then be opened working progressively away from the storage tank until chlorinated water is delivered from each tap, which should then be closed.

7.7.3 The tank should then be topped up with water by opening the mains supply valve and further chlorinating reagent added. The system should then remain charged for a period of not less than 3 hours after which a test should be made for residual chlorine. If none is found the sterilisation will have to be carried out again.

7.7.4 Finally the system would be thoroughly flushed out before any water is used for domestic purposes.

7.7.5 The contractor shall provide all necessary tanks, dosing chemical etc necessary to complete the above.

7.8 TESTS

7.8.1 After completion of the installation the whole of the pipework shall be subjected to a hydraulic test to a pressure of 6 bar. The ends of all supplies to fixtures shall be blanked off before the test is carried out.

7.8.2 Brackets securing piping shall be loosened up to allow for straining of the pipe while under pressure. The system shall be subjected to the test for a period of not less than 24 hours and shall remain drop tight for the duration of the test.

7.8.3 The Contractor shall give at least 14 days' notice in writing to the Engineers prior to carrying out the test.

7.8.4 The contractor shall then carry out a complete test of each service from source position to final drops.

7.8.5 The Contractor shall include for surveying and recording all hot water tap outlet/blend valve outlet temperatures of the completed balanced and commissioned water services installation. Record results shall be presented in a format showing –

- Station Location
- Station Type
- Service (HWS, blended HWS)
- Measuring device used
- Temperature balanced and recorded

8 HEATING INSTALLATION (ELEMENT 56)

The works covered in this section shall comprise the following:

1. Complete installation of LPHW water pipework installations including the installation of/connection to low surface temperature emitters/underfloor heating manifolds.
2. Complete installation of electric radiators.
3. Complete testing and commissioning of the LPHW and underfloor heating installation.
4. Complete testing and commissioning of the electric radiators.

8.1 ELECTRIC RADIATORS

Radiators shall be provided as part of the described electric radiator heating system. The Contractor shall allow in their Tender for erecting the radiators twice and dismantling once, facilitating other trades.

The radiators shall be the vertical lined panel type and shall have the following specification for any staff space as indicated on the drawing and schedule;

- Electric radiator in steel with heat transfer fluid (unalterable mineral oil - no maintenance required).
- Horizontal non-joint flat elements or vertical (70 x 11 mm) double thickness, on steel collectors with a Ø 38 mm section.
- Elements assembled at each end on collectors by welding with spacing of 4mm.
- The wiring is just live and neutral, no earth as it is double insulated.
- Radiators to be controlled via BMS interface and activated by BMS linked space temperature sensor.
- The steel shall be min. 1.25mm thick.
- Standard colour White RAL 9016 glossy or optional colour finish. 2-coat paint, autophoretic primer and epoxy lacquer polyester finish.
- Electric Immersion heater with automatic circuit breaker.
- The warranty shall be minimum 2 years for the electrical components and 5 years for the body of the radiator.
- Outputs are to be tested in accordance with EN14037 and EN442.

8.2 LOW SURFACE TEMPERATURE (LST) EMITTERS

8.2.1 The Contractor shall allow in their Tender for erecting the radiators twice and dismantling once, facilitating other trades.

8.2.2 Include for Each sensor and 2 port modulating control valve, wired to the building management system for rooms noted on the drawing requiring thermometer control.

Low surface temperature emitters (LST) shall operate at temperatures not exceeding 43^0C surface touch temperature and manufacturer certification to EN 442 shall be provided to that effect, for the emitter installed for any public facing spaces as noted on the radiator schedule in the mechanical services schedule document.

Outputs and casing touch temperatures shall be certified in accordance with EN 442 and be CE certified. The LST emitters shall be complete with Low-H_2O heat exchangers (low water content efficient technology). In addition to the above the LST emitters are to meet the following criteria.

LST Radiators shall be installed at 100mm above floor level to allow for cleaning underneath to prevent bacterial proliferation.

Casing:

- The casing shall be super strong with profiled front plate in 1.5 mm thick steel and complete with rounded angles to avoid injury to occupants.
- Unit to be supplied with chamfered corners.
- The Low-H2O technology shall guarantee powerful heat emission and low contact temperatures. The casing surface temperature shall not exceed 43ºC on the emitter casing and on grilles for the LPHW system operating temperature. Emitters shall be certified to the above by the manufacturer. The casing shall also comply with the safety requirements NHS DHSS DN4 document.
- Scratch-resistant surface coating with a satin gloss finish and high UV resistance shall be included.
- Be available with Standard and Non-Standard colours without surcharge, sandblast grey metallic (001) typical, to the approval of the architect.
- Shall be complete with a 10 year guarantee
- Heat exchanger valve body can be accommodated within the casing.
- Complete with casing locks for extra security.
- Complete with Pencil-proof grille positioned behind each standard grille face.
- Complete with 2 No. standard ,top and underside, grilles per wall mounted LST casing.
- Casing shall can be wall mounted.
- Casing shall be complete with safety screws which are only removable with specialised equipment bit/tool.

Heat Exchanger:

- Heat exchanger shall be of pure copper and aluminium, totally non-corrosive as an emitter and be complete with 30 year guarantee.
- Same end connection, left or right, with simple valve, TRV or remote
- Control capillary stat option.
- Shall be pressure tested to 20 bar.
- DHSS DN4 Compliant.
- Shall be efficient, provide rapid heat up to super low water content
- Low-H2O heat exchanger with dirt-repellent and dust-proof lacquer in graphite grey (RAL 7024).
- Standard with extended air vent with transparent synthetic drain tube.
- Heat Exchanger must have corrugated fins and be designed as a Low H2O technology efficient heat exchanger. Low water content – 0.98 litres per metre length of single exchanger section or less.
- Heat exchanger to be complete with 4-port thermostatic control valve and control thermostat control head/remote capillary thermostat bulb, per unit and as per schedule.
- Low H2O heat exchanger manufactured from round, seamless tubes made of pure red copper to EN12735-2, with corrugated pure aluminium fins and two brass collectors. Aluminium fins feature collars for maximum surface area contact

between tubes and fins. Brass collectors complete with 2no. ½" BSP brass connections. Same end connections suitable for left and right hand installation.

8.3 UNDERFLOOR HEATING

8.3.1 The Mechanical specialist shall include for the supply and installation of the underfloor heating in the areas as indicated on the Underfloor Heating Drawing.

8.3.2 Materials and underfloor heating installation method shall conform to the following standards and references;

- DIN 4725 (Hot Water Floor Heating Systems)
- DIN 4726: Warm water floor heating systems and radiator pipe connecting—Piping of plastic materials
- BS EN 1264:2001 (Underfloor heating systems & components)
- EN ISO 15875-1:2001 (PE-X Pipe)
- BS 8204 (Concrete & Screed Data) Bunn & Roberts (2003)
- Screeds with Underfloor Heating – Guidance for a Problem Free Interface. BSRIA / The Concrete Society
- Sutherland (2004) Underfloor Heating Design & Installation Guide, CIBSE
- BISRA application guide, pre-commissioning cleaning of pipework systems (2nd edition)

Underfloor Heating Design

8.3.3 The system shall be designed in strict accordance with BS/EN 1264: 1988 / DIN 4725. The system shall be designed to meet the following conditions based on an outdoor temperature of -3^{O}C and in accordance with the proposed heating layouts and the following design criteria:

Outside design temp	-3° C @ Design flow 35°C
Reception Area	21° C
External Walls	0.20 W/m²/°C
Ground Floors	0.18 W/M²° C
Windows	1.60 W/M²° C
Air changes @	1.5 per hour

8.3.4 The entire system shall be backed by a 10-year manufacturer's warranty, which shall cover consequential damage due to system failure. Underfloor heating pipework shall have a minimum warranty of 25 years.

8.3.5 The specialist supplier shall provide AutoCAD drawings indicating the layouts of the pipe work, a schematic diagram of the system and all necessary wiring details.

8.3.6 A contractor trained and certified by the specialist supplier shall carry out the pipe work installation and verify the installation is installed according to the required standards.

8.3.7 Installation test certificate provided by the specialist supplier must be signed on site for each manifold by the senior installation engineer and countersigned by the site foreman prior to screeding.

8.3.8 Design criteria must specify a 35°C design flow temperature will overcome all heat losses within the building when outside temperature goes below -3°C. The designed system must certify a fully functional system at -10°C external temperature for periods of at least 14 days consecutively will maintain 21°c in all areas.

8.3.9 The design must show a print out of the following information for each zone/room separately:

- Number of circuits in each (room) zone
- Pipe length for each circuit in meters
- Floor temperature in each zone and return water temperature in each zone
- Heating capacity per meter squared output in the zone in W/m²
- Pipe spacing in occupied zones in millimetres
- Pipe spacing in occupied zones in millimetres
- Occupied zone area and perimeter zone area in m²
- Flow quantity per circuit in kg/hr
- Water velocity litres /sec in each circuit
- Pressure drop across each circuit in Pascals
- Actual floor temperature in each zone (room)
- Total pressure drop in kPa across the system
- Flow temperature in ºC @ -1°c external
- Mean return temperature in º Kelvin
- Water content for entire underfloor heating
- Max pressure loss for the entire heating system, Pascals
- Max pressure loss for each manifold, Pascals
- Total flow quantity for each manifold, litre/sec
- Total flow quantity for entire heating system, litre/sec
- Total heated area in m²
- Total heat load/required input in kW/h
- Total output of UFH in kW/h

8.3.10 The flow temperature must vary according to external weather conditions, to allow internal temperatures to stabilise and prevent overheating. Weather compensator must accept UFH parameters.

8.3.11 The design must allow for a flow temperature of 35°C at outside temperature is at -1°C capable of achieving a room temperature in all rooms above 22°C maximum. The maximum flow temperature regardless of the weather is 50°C. The maximum floor temperature must not exceed 29ºC in occupied areas at any time during operation.

8.4 RADIATOR VALVES

8.4.1 All radiators and LST emitters shall be fitted with an approved thermostatic control valve. The thermostatic control valve shall have a 9°C - 29°C setting range.

8.4.2 A similar valve of the lockshield angled type shall be provided for permanent regulation. All valves shall be supplied by the radiator manufacturer. Radiator control valves shall be chromium plated "easy clean" type. 1 No. lockshield valve key per 20 No. radiators shall be provided and handed over to the Client on completion of the contract. Valves shall be heavy duty type complying with BS 2767: 1991. The valves shall comply with IS EN 2004 AMD1-2006.

8.5 AIR VALVES FOR RADIATORS.

8.5.1 A recessed type of gunmetal air cock shall be provided and fixed to each radiator. Keys shall be provided for operating these valves. 1 No. key per 20 No. radiators shall be handed over to the Client on completion of the contract

8.6 EXPANSION DEVICES

8.6.1 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.

8.6.2 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.

8.6.3 Expansion joints shall be provided with screwed or flanged ends as appropriate. They shall incorporate internal liners if required and shall be manufactured from corrosion-resistant steel, or other approved material appropriate for the duty, and designed to withstand the test pressure of the system.

8.6.4 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.

The following are the minimum guidelines for pipework expansion loops.

EXPANSION LOOP SIZES		
PIPE BORE (INTERNAL DIA)	**Distance between anchor bracket on horizontal run.**	**Depth of pipe loop**
Up to 25mm bore	400mm	600mm
32mm to 40mm bore	650mm	750mm
50mm to 65mm bore	1000mm	900mm
80mm bore	1200mm	900mm
100mm bore	1500mm	1100mm
150mm bore	2100mm	1500mm

8.6.5 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.

8.6.6 Adequate provision shall be made at all connections to equipment and appliances to avoid stress due to contraction and expansion.

8.7 THERMOSTATIC CONTROL VALVES

8.7.1 Thermostatic valves shall be manufactured in accordance with EN215, shall be pre-settable type and shall be of cast brass construction with 'O'-ring seal. Removal of the valve insert must be achievable while the system is live and under full working conditions using a dedicated tool, allowing subsequent replacement or servicing. Thermostatic valve inserts to have a pre-setting function allowing the kv of the valve to be selected in accordance with valve charts to enable system balancing to be achieved.

8.7.2 The Contractor shall supply and install thermostatic control valves on all emitters as scheduled, refer to MS02 document and drawings. The valves shall be fitted on the flow connection to the emitters in a location approved by the Engineer.

8.7.3 The valves shall comply with IS EN 2004 AMD1-2006 and EN215. They shall be straight pattern with tamperproof sensor head. The valve shall have a 9oC - 29oC setting range.

8.8 TESTS

After erection is completed, the whole of the piping, valves and fittings shall be tested under hydraulic pressure excluding heat emitters.

Tests shall be carried out in accordance with relevant Section “Inspection, Testing & Commissioning” of this Specification.

9 VENTILATION INSTALLATION (ELEMENT 57)

9.1 EXTENT OF WORKS

The works covered under this section shall comprise of the new local toilet extract systems. The new Heat recovery ventilation unit to meeting rooms and large group rooms. All as indicated on the (57 series) drawings.

9.2 DUCTWORK

General

The following specification covers the installation of ductwork and fittings as shown on the drawings and detailed in the contract documentation. Duct sizes indicated on the drawings are clear internal dimensions and shall not be altered without written request to, and approval from, the Engineer.

Ductwork materials, construction and installation shall comply with the relevant parts of the following publications:

HVCA DW/144:	Specification for sheet metal ductwork - low, medium and high pressure/velocity systems
HVCA DW/143:	A practical guide to ductwork leakage testing
HVCA DW/154:	Specification for plastics ductwork
HVCA DW/171:	Guide to good practice for kitchen ventilation systems
HVCA DW/191:	Guide to good practice for glass fibre ductwork
HVCA TR/19:	Guide to good practice, cleanliness of ventilation systems
HVCA DW/TM2:	Internal cleanliness of new ductwork installations
BS 8313:1997	Accommodation of Building Services in Ducts

The Contractor shall be responsible for taking all measurements on site and as necessary for the fabrication and erection of ductwork. Where site dimensions cannot be obtained in advance of shop drawing preparation, the Contractor shall make suitable provision to accommodate any discrepancies that may arise between the drawings and site dimensions.

Lengths of ducts and other constructional details shall be selected to achieve maximum economy of manufacture and erection, subject to compliance with construction standards and access into buildings.

Ductwork shall be constructed and erected to present a rigid installation free from sway, drumming and movement. Ductwork which, in the opinion of the Engineer, is misaligned, unsightly, sharp-edged or otherwise below standards of first class workmanship shall not be accepted.

Allowances shall be made in ductwork construction for instrument and controls connections, and adequate local stiffening shall be incorporated to provide rigid mountings.

Where ductwork is required to be internally lined, the dimensions of the ductwork shall be such that the required airway cross-sectional area is maintained. Fixings shall be such that lining or insulation is maintained in contact with the duct surfaces under all operating conditions and the detachment and migration of fibres, etc. is prevented.

All ductwork located exposed or in ceiling voids above fire escape routes shall be completely fire-rated.

Where ducts pass through roofs or external walls suitable weathering aprons or purpose-made arrangements shall be provided to ensure weatherproof fixing.

Adequate precautions shall be taken to prevent transmission of noise and vibration from ductwork to occupied spaces and structure.

As far as is practical, longitudinal seams and joints in adjacent ductwork sections shall be aligned, particularly where permanently visible after installation.

Perforated rivets shall not be used in manufacture or erection of ductwork. The use of self-tapping screws shall be restricted to the completion of site joints in extremely difficult locations only.

Where required, hand holes to permit proper joining of duct sections shall be provided at the manufacturer's discretion but shall be kept to a minimum and made as small as practicable. They shall be rendered airtight with sealant and securely fastened.

The Contractor shall refer to the relevant section of this Specification for details of the required level of cleanliness of ductwork.

The Contractor shall refer to the relevant section of this Specification for details of pressure testing requirements.

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

9.2.1 Galvanised Ductwork and Fittings

Materials and construction shall comply with DW/144. The ductwork classification shall be as indicated.

All fittings, joints, stiffeners, fastenings, sealants, gaskets, etc. shall be in accordance with DW/144 and with the following:-

Fire Resisting Ductwork and Fittings

Fire resisting ductwork and fittings shall be constructed to BS 5588 and comply with the

performance criteria within BS 476 and shall be of the same fire rating as the compartment wall or floor through which the fire resisting ductwork passes.

Where the fire resisting ductwork passes through a fire compartment wall or floor, a penetration seal shall be provided which has been tested with the ductwork to BS 476, to the same fire rating as the compartment wall or floor through which the fire resisting ductwork passes. In addition, the ductwork itself shall be stiffened to maintain the cross-sectional area of the duct and prevent deformation of the duct in a fire, and to ensure that the fire rated penetration seal around the duct is not compromised.

Both the supply and extract ductwork to and from the Isolation Suites shall be fire rated.

Flexible Ductwork

Flexible ductwork shall be installed as indicated on the drawings, and where required between rigid ductwork and items of equipment.

Unless otherwise indicated, flexible ductwork shall be constructed in aluminium. It is the responsibility of the Contractor to ensure that flexible ductwork meets the requirements of the relevant fire authority.

The frictional resistance to air flow per unit length of flexible duct shall not exceed 150% of the frictional resistance per unit length of galvanised steel duct of similar diameter.

Flexible ductwork shall be kept to a minimum and shall not be used between rigid sections of ductwork to change direction. Kinked or flattened ductwork will not be accepted. Sagging shall be prevented by use of wire loop tie supports as necessary. Test holes shall not be formed in flexible duct.

The maximum length of each flexible duct section shall be 1.0m. Connections shall comply with DW/144.

Flexible ducting shall comply with the air-tightness requirements for the rest of the ductwork system of which it forms part.

Flexible Joints

Flexible joints shall be fitted at fan inlet and outlet connections, building expansion joints and elsewhere as required. Care shall be taken to maintain alignment between the fan and the duct connection.

Flexible joint material shall have a fire penetration time of at least 15 minutes when tested in accordance with BS 476 and shall remain flexible without strain or distortion.

Flexible joints shall be kept as short as practicable above a minimum effective length of 50 mm. In no case shall a flexible joint exceed 250 mm in length.

Flexible joints shall comply with the air tightness requirements for the rest of the ductwork system of which it forms part.

9.3 HANGERS AND SUPPORTS

The supply and installation of hangers and supports shall be in accordance with DW/144 and with the following:-

In addition to hangers and supports required for ductwork generally, ductwork supports shall be positioned close to dampers, diffusers and all similar equipment, which must not be subjected to distortion.

Hangers for ducts that require thermal insulation shall be spaced to provide clearance for the insulation.

Supports where vapour seal treatment is required shall be external to the insulation.

Fire resisting ductwork shall be supported with suitably sized and designed hangers which reflect the reduction in tensile strength of steel in a fire condition.

All sharp edges and cut ends shall be suitably protected. Threaded rods supporting hanger brackets shall be trimmed off in accordance with Health and Safety Regulations.

9.4 ACCESS OPENINGS

Access openings and inspection covers for the inspection, cleaning and servicing of plant and equipment must be provided in accordance with DW/144. Access openings and clean out doors for the internal cleaning of ductwork must be provided in accordance with the requirements of HVCA TR/19 and BS EN 15780-2011. All access openings shall be fitted with a chain connected to the main body of ductwork or ductwork support. Access openings on fire rated ductwork shall be also be 60 minute fire rated. Openings shall be provided on the ductwork systems at all locations as per Table 2 of TR/19 and be sized in accordance with Table 1 of TR/19. Notwithstanding the requirements of TR/19, access openings should at a minimum be located at every bend, change in direction, every 10m on horizontal ductwork distribution, at high, medium and low level on vertical risers and at either side of fire dampers, fire-smoke dampers, volume control dampers, constant volume boxes, attenuators, filters on the ductwork systems. Access openings for cleaning and inspection purposes shall be proprietary insulated type, factory cut with smooth seamed finishes without any coarse or sharp edges. On site cutting for access shall not be permitted. All ducting access requirements shall be indicated on the contractors coordinated services drawings, which are required to be presented to the Engineers six weeks in advance of the services installation works commencing.

The Mechanical Contractor must ensure that access openings are not obstructed by pipework, cable trays or any other obstacle and that they are fully accessible for future use. Where practical, openings must be arranged so that they are accessible from circulation areas to minimise disruption in occupied rooms.

9.5 TEST HOLES

Test holes for plant system commissioning shall be fitted with 13mm diameter easily removable rubber or neoprene sealing plugs. Test holes shall be provided in locations specified in DW/144, local to plant and also in all branch ducts.

9.6 CONNECTIONS TO BUILDER'S WORK

Connections to builder’s work shall be as detailed in Architects documents

9.7 PROTECTIVE FINISHES

Protective finishes shall be as detailed in Architects documents

9.8 DAMPERS

9.8.1 **General**

All mechanical ventilation extracts shall be fitted with dampers that shut off when the fan is not in use and in particular when the building is closed.

The general constructional requirements of dampers shall be in accordance with DW/144. The respective functions and types shall be as indicated. Damper frames and blades shall be constructed to ensure rigidity and prevent distortion and jamming in operation. The blades shall be securely fixed to the operating spindles so that differential movement cannot occur.

Manually and automatically operated dampers shall include a means for indicating externally the position of the blades. Manual dampers shall include a device for positioning and locking the damper blades. Ratchet and pawl locking devices are not acceptable.

Air leakage through dampers when in the closed position shall not exceed 5% of the maximum design air volume flow rate at the maximum design air total pressure.

All dampers shall be positioned in easily accessible locations. Dampers beyond reasonable access by ladder, etc. shall be provided with substantial sheathed flexible operating gear extended to normal working height.

Dampers shall be installed in accordance with relevant Standards, Building Regulations and Local Authority requirements as well as the manufacturer's recommendations.

9.8.2 **Regulating Dampers/Motorised Dampers**

Unless otherwise indicated, regulating dampers shall be multi-leaf, opposed blade type. The blades shall be adjustable through a nominal 90° angle simultaneously being interconnected linkage or gears, connected to a quadrant or similar operating mechanism. Where automatic control of the damper is required, maximum width shall be 1200mm and a spindle shall be extended to enable a powered actuator to be mounted. The actuator shall be securely fixed to damper frame and spindle. Automatic control dampers for natural ventilation application shall be ultra low leakage to DIN 1946 Part 4 and double skin insulated for energy saving. Bearings requiring lubrication shall be accessible.

All balancing dampers shall have a locking device located on the outside of the case and shall give clear indication of the actual blade position. The position of all dampers, as set after final regulation, shall be permanently marked at the adjusting device.

Unless otherwise indicated, balancing dampers shall be provided in the following locations:-

In each branch from a main or sub-main.

At all plant discharges.

On individual branches to all grilles and diffusers. Dampers shall be located as far from the grille or diffuser as practicable.

9.8.3 **SMOKE AND FIRE DAMPERS**

Smoke/fire dampers shall comply with the relevant clauses of this specification for fire dampers in addition to the following.

Unless otherwise indicated, smoke/fire dampers used singly or in combination shall have an

overall fire rating not less than 2 hours. In all cases, evidence of fire rating in accordance with IS EN 1366-2: 2000 and/or ISO 10294-1:1996 shall be provided.

Casings and blades shall be constructed from galvanised sheet steel to IS EN 10346:2009. Dampers shall be opposed or parallel blade operation. Damper blades shall have standard face linkage.

Blade edge seals shall be high temperature silicone rubber and stainless steel compression seals shall be used to control leakage at the jambs. Bearings shall be oil-impregnated bronze.

The relevant clauses as indicated above for fire dampers shall also apply.

Each damper assembly shall be equipped with an electric or pneumatic actuator as indicated. Where indicated, an automatic smoke/fire damper control system shall be supplied and installed.

SMOKE/FIRE DAMPER CONTROL SYSTEM

The Mechanical Contractor must supply and install an intelligent damper control system with control panel located as shown on the drawing. The system shall comprise of a smoke/fire damper control panel serving dampers within the building.

The smoke damper control panel shall be complete with LCD display to show the status of all dampers in list form and on board electronic pushbutton controls to facilitate the individual control and monitoring of all dampers wired to the panel. The system must communicate with damper interfaces to provide control and monitoring of all dampers.

The system shall meet the following criteria:

- Shall be capable of accommodating unlimited fire zones
- Individual or collective damper control
- Continuous damper monitoring
- Wall mounted enclosures to IP55
- LCD display screen
- Single or multi zone inputs
- Custom engraved traffolite fascia
- Miniature circuit breaker protection for outgoing supplies and control wiring
- Test switch
- Audible alarm with mute facility
- B.M.S. common fault relay interface
- B.M.S. Output
- Delay timers
- Battery backup
- CE marked, LVD and EMC EN60204 compliant.
- Compliance with BS EN 12101-9, BS5588 & BS5389

The Mechanical Contractor must include for smoke / fire damper interface units (SFDI) to be supplied at each smoke / fire damper. The installation of these SFDIs must be included as part of the Mechanical Contract. The contractor should note that IP66 rated SFDI are required where IP66 rated dampers are to be installed.
The Mechanical Contractor is to include for the entire system to be supplied, installed, wired, tested and commissioned by the specialist damper control system supplier. The electrical contractor will bring mains power to each SFDI and shall include for wiring network cables to SFDIs however all connections must be terminated by the specialist damper control system supplier.

The Specialist supplier will have strict requirements and conditions to be met prior to commissioning of the damper control system. It is the responsibility of the Mechanical Contractor to ensure that the entire installation is as per the specialist suppliers requirements and in accordance with DW 144, EN 1366-2:1999.
The specialist supplier must provide give a full demonstration to the client and provide as installed documentation as per the relevant sections of this specification.

9.8.4 Non-Return Dampers

Non-return dampers shall be of the motorised type and shall be arranged to close on detection of failure of airflow, except those for small packaged twin-fan extract units.

9.9 SUPPLY/EXTRACT GRILLES AND DIFFUSERS

The Contractor shall provide for the supply and installation of intake and extract grilles and diffusers as shown on the drawing. The grilles and diffusers shall be of mainly aluminium construction. Where steel frames are required, they shall be powder coated. All grilles and diffusers shall be supplied with volume control dampers and connecting collar.

Ventilation Grilles

Ventilation grille in rectangular construction, suitable for installation into circular or rectangular ducts, comprise front face with mitred border including counter punched holes for fixing, rear perimeter sealing strip and individually adjustable vertical and horizontal blades.

The grilles shall have angled hit and miss damper incorporating airflow straightener, adjustable from the grille face.

Disc Valves

Circular disc valves, suitable for supply and extract air, comprising valve ring with peripheral seal, central disc with threaded spindle and locknut and installation sub-frame with volume flow rate adjustment by rotating the central disc.

Ceiling Diffusers

Square or rectangular construction ceiling diffusers, suitable for horizontal air discharge, with 1 to 4 ways discharge, consisting of diffuser face with mitred perimeter border which is counter punched for screw fixing on site and has fixed blades for horizontal discharge, border has rear sealing strip. Rear mounted opposed blade volume control damper adjustable from the front face of the diffuser.

Grilles shall be as indicated on the drawings and outlined in the schedules.

9.10 FANS

9.10.1 General

The Contractor shall include in their tender for the supply and installation of extract fans as indicated on the drawings and as scheduled. All supply/extract fans shall be supplied complete with Variable Speed Drives.

Values of the resistance to airflow 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, ductwork layouts, ductwork sizes, etc. shall be brought to the attention of the Engineer. The Contractor shall ensure that the fans provided are capable of delivering the required airflow when operating against the actual total system resistance.

Fans shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during continuous operation and during speed and duty changes. Additionally, belt-driven fans shall be capable of running continuously at 10% in excess of the selected duty speed and shall have a minimum of two belts.

The shaft and impeller assembly of all fans shall be statically and dynamically balanced to BS 6861-2: 1997.

Mechanical and electrical safety provisions and testing of fans shall be in accordance with the requirements of BS 848 - : 1997.

Vibration isolation, fan drive arrangements, electric motors and guards shall be in accordance with the relevant clauses of this Specification. Anti-vibrational mounts and purpose made support steel framework shall be provided by the contractor for all fans installed under these works.

The Contractor shall provide all necessary holding down bolts for fixing the equipment and shall mark out and supervise the formation of all bases, curbs and weathering details as may be required and which will be constructed by others.

The Contractor shall be responsible for final tuning of fan duties on site to achieve the required air flow when operating against the actual total system resistance. Electrical details of the fans shall be in accordance with the Schedule of Fans. Each fan shall be supplied with a starter, with overload protection and speed controllers. Fan motors shall be speed variable suitable for inverter control where specified.

Schedule of Fans (refer to MS02 Schedules document)

Axial Flow Fans

Impellers shall be of mild steel protected against corrosion, aluminium or moulded reinforced plastics. Blades shall be of aerofoil section and unless otherwise indicated, shall be capable of pitch adjustment.

Fan casings shall be rigidly constructed of mild steel or aluminium alloy and shall be complete with an access door, mounting feet, anti-vibration mountings, and flanged connection spigot to take flexible connectors.

For in-duct mounted fans, the length of the fan casing shall be greater than the combined length of the impeller and motor.

Bifurcated Fans

Impellers shall be of mild steel protected against corrosion, aluminium or moulded reinforced plastics. Blades shall be of aerofoil section and unless otherwise indicated, shall be capable of pitch adjustment.

Fan casings shall be rigidly constructed of mild steel or aluminium alloy and shall be complete

with an access door, mounting feet, anti-vibration mountings, and flanged connection spigot to take flexible connectors.

Motors shall have IP55 rating and shall have access to ambient air.

Centrifugal Fans

Unless otherwise indicated, fans in air handling units shall be belt-driven double-inlet centrifugal type with a fan total efficiency of not less than 60% and 50% for backward and forward curved types respectively. The fan section shall be tested in accordance with BS 6583:1985.

Unless otherwise indicated, centrifugal fans consuming more than 7.5kW at the fan shaft shall be backward curved type with aerofoil blades, selected for operation at a fan total efficiency not less than 80%.

Where applicable, fan casings shall be of mild steel sheet, with welded or riveted joints and welded angle stiffeners, constructed to permit withdrawal of the fan impeller. A plugged drain shall be fitted at the lowest point in the casing.

Permanent indicators shall show the direction of rotation of the impeller. Casings shall have access panels with air seals to facilitate maintenance.

Impellers shall be of mild steel protected against corrosion or aluminium alloy and shall be of bolted, riveted or welded construction.

Packaged Twin Fan Extract Units

Housings and cowls shall be manufactured from galvanised mild steel or aluminium alloy sheets or glass-reinforced plastics. Externally mounted units shall be weatherproof. Unless otherwise indicated the fans shall be arranged for automatic changeover and shall be complete with back-draught dampers. Each fan shall be provided with separate motors and independent drives and shall be capable of delivering the full air volume specified at the stated pressure.
Protectively Coated Fans

Where fans are required to handle toxic, corrosive, flammable, explosive or high temperature gases the materials of construction shall be as indicated and all relevant safety regulations shall apply. Fans shall meet the appropriate requirements of the above clauses. The coating shall cover all parts of the complete fan, motor and casing assembly that will be in contact with the gases. No fan shall be installed if the coating has been damaged.

Roof Extract Units

The fans used in roof extract units shall meet the appropriate requirements of the above clauses. Cowls and bases shall be appropriate to the location and shall be of weather-resistant materials. Casings shall be complete with integral weatherproofing provisions suitable for direct fixing to the building structure.

Adequate access to electrical supply terminals and lubrication points shall be provided. Back-draught dampers shall be provided and fire release dampers shall be fitted where required.

Electrical details of the fans shall be in accordance with the Schedule of Fans. Each fan shall be supplied with a starter, with overload protection and speed controllers. Fan motors shall be speed variable suitable for inverter control where specified.

Fans shall be as indicated on the drawings and outlined in the schedules.

9.11 LOUVRES

Air intake and discharge openings shall be protected by framed louvre bladed sections. Louvres shall be weatherproof with horizontal angle blades to prevent entry of driving rain, snow and heavy particulate matter. Louvres shall restrict rain penetration to the appropriate classification of the HVCA test method. The minimum effectiveness shall be 0.95, class B.

External louvers shall be proprietary fixed blade type fabricated from galvanised mild steel sections and sheet or from aluminium alloy of adequate stiffness to prevent vibration and/or damage, and shall be so designed to prevent the ingress of rain. Louvres including fixings shall be fully protected against corrosion and finish shall be as indicated.

Louvres shall be complete with galvanised wire bird screen to be fitted to the inner face, to be removable for cleaning and be 10mm mesh size. Blanking plates shall be provided where required.

Unless otherwise indicated the method of fixing louvres shall be by bolting through the casing flange or side casing to structural members. An effective weather and acoustic seal shall be achieved using packing and filling materials as necessary.

Acoustic louvres shall be provided where indicated and shall consist of a rigid casing, housing double-skin blades having plain top surfaces and shaped, perforated undersides, to achieve maximum attenuation, utilising infill material packed in sealed plastic film containers.

Penthouse louvres shall be constructed from standard louvre units with fabricated corner sections and sheet metal sloped roof.

Ductwork immediately behind or below an intake or exhaust louvre shall be painted on all internal surfaces with epoxy resin or bitumastic paint for a length from the louvre equal to the louvre height or to the nearest equipment item, whichever is the lesser. The bottom of the ductwork shall have a 15° minimum slope downwards towards the louver or be tanked and adequately drained to remove deposits of moisture.

Unless otherwise indicated, external louvres shall have a minimum 50% ‘free area’.

The Contractor shall supply the manufacturer with all relevant information required to ensure that the louvres meet all of the requirements of the Specification, including their suitability with regard to weathering.

9.12 TESTING AND COMMISSIONING

General

Client’s representatives will be present for the start-up of all major ventilation plant and automatic control systems.

Certified Testing and Balancing Specialist will test, adjust, balance and commission systems resulting in proper operation of individual pieces of equipment and also the proper operation of the overall ventilation systems, in accordance with CIBSE Commissioning Codes A, B, C, M, R, other

applicable Guidelines and ETCI Regulations.

Performance testing of all equipment and systems for part load and full load during summer, winter, spring and autumn seasons will be demonstrated to validate system performance.

The Contractors shall be responsible for commissioning the entire mechanical and electrical services for all phases and stages of the installation to the satisfaction of the Engineers. The Contractor shall produce for the approval of the Engineers a detailed specification for commissioning Procedures for the completed installation. This Specification shall be provided well in advance of the commissioning programme and at a time agreed with the Main Contractor.

The Commissioning Procedures Specification shall include the following:

- Detailed operating programme.
- Bar chart showing weekly analysis of programme.
- Data to be used for each stage of commissioning.
- Detailed commissioning schedules for each item of plant and equipment.
- Requirements and involvement of Consulting Engineer and Facilities Management Staff.
- Method of logging all performance data with processing and issuing to Client's representatives.
- Method of issuing certificates including suppliers certificates.
- Instruments and method of measurement to be used in commissioning.
- Instructing Staff in use of plant and systems.

The Contractor shall co-ordinate with the respective Mechanical/Electrical Contractor in arranging a seminar to present and explain the commissioning methods and programme they proposes for the installation. They shall also arrange for all specialist suppliers/installers involved in the mechanical/ electrical installation to be in attendance to outline their own commissioning procedures.

The Contractor shall supply sufficient lubricating oil and other consumable materials to allow the complete commissioning and testing of the equipment within their scope.

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.

The Contractor shall be responsible for ensuring that tests by nominated suppliers are properly carried out.

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.

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.

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 their 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.

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.

Inspection

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.

All plant equipment and system components shall be installed, adjusted and set in accordance with the manufacturer's instructions.

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.

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 their work.

Cleanliness

All systems shall have been cleared of any obstruction and cleaned externally and internally before commissioning and testing.

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.

Ductwork Distribution Systems

Unless otherwise indicated, ductwork shall be delivered to site, stored and cleaned to 'Intermediate Level' to HVCA DW/TM2.

On completion of the works and before any system is put into operation the Contractor shall ensure that the complete installation is thoroughly cleaned out and all foreign matter removed. The ventilation systems shall be completely cleared after being blown through using installed fans or by agreed alternative. Cleaning shall be completed before the connection of terminal units and devices.

Unless otherwise indicated, the Contractor shall provide a certificate confirming that the procedures outlined above have been carried out.

Pressure Testing

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.

Installations or sections of air 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.

Commissioning

The Contractor shall be responsible for proving the performance of all equipment and installations and for the correct balancing of air systems in accordance with the relevant codes.

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.

The Contractor shall submit samples of the commissioning specialist's test sheets to the Engineer for comment. TM3 Test sheets available from the commissioning specialist association (CSA) are preferred.

Unless otherwise indicated, the Contractor shall submit a commissioning schedule and programme to the Engineer at least 6 weeks before commencement of commissioning.

Commissioning shall include:

- Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start-up as detailed previously.
- Preliminary setting and adjustment of all plant and equipment consistent with eventual design performance.
- Energising and setting to work of all plant.
- 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.
- 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.

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.

Performance Testing

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 air systems are established, that the systems provide the required internal conditions and to assure themself 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.

Demonstration and Hand-Over

The Contractor shall include for the requisite man-hours for the demonstration, instruction and hand-over of the mechanical services installation to the Employer.

The Contractor shall ensure that record documentation is handed over to the Employer two weeks prior to demonstration.

10 AUTOMATIC CONTROLS (ELEMENT 59)

10.1 SCOPE

The following specification covers the design, supply, delivery, installation, supervision, testing, commissioning and demonstration of automatic controls/building management systems by a specialist supplier as part of this contract under the direction of the Mechanical specialist, and shall be read in conjunction with all **relevant sections** of this Specification, the drawings, and the electrical services specification.

The mechanical specialist shall forward to the Engineers a full and complete BMS points list associated with the entire BMS installation, this document shall be submitted well in advance of works proceeding.

Unless otherwise indicated, the general allocation of responsibilities shall be as follows:-

Power Wiring

Installation, termination, testing and labelling by electrical specialist. Specialist supplier to verify termination under this contract.

Controls Wiring

Specialist supplier to confirm to electrical specialist signal cabling requirements. Installation, testing and labelling by electrical specialist. Final termination by specialist supplier under this contract.

Controls Devices

Supply and labelling by specialist supplier. Installation by the Mechanical specialist, specialist suppliers or the electrical specialist, as appropriate.

Variable Speed Drives

Supply by the Mechanical specialist. Installation in MCC by specialist supplier. Commissioning by specialist supplier under this contract.

MCCs and Panels

Supply and commissioning by specialist supplier under this contract. Installation by electrical specialist.

Drive Sizes

The specialist supplier shall issue a questionnaire for information required and the Mechanical specialist shall advise the specialist supplier and the electrical specialist of all relevant manufacturers details.

10.2 BUILDING MANAGEMENT SYSTEM

(A) General Overview

A building management system is required to support the building services and plant equipment on each floor.

The supplier shall include for the production of software code for the BMS, which shall

incorporate the control logic for the new inputs and outputs to the BMS. Plant equipment as generally described hereunder is controlled and/or monitored by the building management system

Air Source Heat Pump
Low Pressure Hot Water Pumps and Equipment
Pressurisation Unit
Extract Fans
Main and Sub-Main Circuit Breakers
Radiator Panel 2-port valves
Smoke/Fire Dampers

(B) Network Controllers / Outstations

The Supplier shall supply the required quantity of outstations to interface with the inputs/outputs (I/O) for all controllers, sensors and actuators associated with plant equipment, as listed in the MCC Schedule of Equipment. In addition, there shall be provision for 30% excess I/O points for both the analogue and digital points count, equally distributed over all outstations.

I/O's relating to starters and equipment directly fed from and connected to the MCC panel shall be connected to BMS Outstations which shall be located within a compartment of the MCC. Outstations for main switchboard shall be supplied by others and located in a control panel on the relevant piece of equipment.

The outstations shall be of the fully intelligent type, capable of performing all control and energy management functions assigned to them, independent of the front end controller.

The outstations shall contain a suitable combination of analogue/digital inputs and outputs to perform the specific control function required.

The outstations shall have battery back up to hold the control strategy in memory for not less than 30 days without power and battery backup will operate if required for a period of not less than 3 years in the event of localised mains failure after installation.
The battery shall not supply 24 V power to the actuators for valves and dampers.

In the event or total memory loss or the expiration of backup power, the necessary data base shall be downloaded on start up from the back up operations on the front end controller.

The outstations shall have a self-diagnostic facility and shall transmit any alarm/malfunction messages to the front end controller if they go off line for any reason.

All software files required to perform the operational functions of the system, under normal operation shall reside in the outstation or system controllers. In the event of a failure of communications between the operator's terminal and any outstation or failure of the site network, all critical alarms, reports and logged data shall be stored in the outstation and shall be transmitted to the front end controller on restoration of the communications network.

There shall be the facility for accessing controller data information locally, via a keypad and display which shall be mounted on the façade of each MCC Panel. Access to the system thus provided shall be restricted by passwords in the same way

as the front end controller.

In order to optimize the operation and speed of processing of points in the controller it shall be possible to individually configure whether a point is processed:-

- On each scan
- On every number of scans
- On a time boundary
- At regular time intervals

Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of status or at specific time intervals. The system shall be capable of expansion to cater for future demand.

It shall be possible to add new controllers to the system without recourse to the manufacturer and without taking any part of the system off-line.

Up to 24 I/O points will be accommodated on each independent outstation. I/O points for individual plant equipment shall, as far as possible, be connected to the same controllers without excess unused points of above 30% of capacity.

(C) MCC Panels

Refer to section 11.6

(D) INTERFACING AND SUPERVISION OF SPECIFIED SYSTEMS

D1 Fire Alarm System

The BMS Shall interface with the Fire Alarm System as indicated on the relevant drawings and as noted in the schedule.

D2 Main Switchboard

The main switchboards shall be linked to the outstation located in the local boiler room.

D3 Plant

The BMS shall interface with the following plant:

	Monitor	Alarm	Control
Air Source Heat Pumps	Yes	Yes	Yes
LPHW Pumps & Valves	Yes	Yes	Yes
Pressurisation Unit	Yes	Yes	No
Extract Fans	Yes	Yes	Yes
Smoke/Fire Dampers	Yes	Yes	No
Main & Sub-Main Circuit Breakers	Yes	Yes	No

Space temperature stats	Yes	No	No

All control modes, monitoring and control functions described in this specification shall be taken into account. Where control of elements of plant is not through the BMS it is expected to be controlled within the plant system.

All Plant Equipment shall be programmed with an automatic restart facility in the event of power failure. Restart of the equipment shall be staged to reduce the impact on the electrical network.

D4 Weather Compensated Circuits

For the radiator circuits, a weather compensator circuit shall be employed. The temperature set points shall be as follows:

-3°C Outside Temperature = 55°C Mixed Flow Temperature
15°C Outside Temperature = 35°C Mixed Flow Temperature

It shall be possible to make minor adjustments to the Mixed Flow Temperature from the front end controller.

(E) USER INTERFACE

The supplier shall include for the supply and installation of a laptop as specified elsewhere and for programming of software and graphics as detailed below.

The presentation of the system shall be via a high resolution graphics system. The graphics shall be of HD resolution.

Coloured graphics shall display system schematics together with the current programmed set points, measured values and plant status for each item of plant. All points on the system shall appear on a graphic slide. Up to 50 points shall be capable of being displayed on each graphic. The following features shall be available:-
Dynamic points from anywhere on the network shall be capable of being displayed on a single graphic slide.

Navigation doors which allow user to move between graphics easily.

Animation of items of plant.

Facility for future addition of minor graphics.

The password control in use at presently shall be mimicked in the additions. Current user names, passwords and access levels shall be retained. The Supplier shall also familiarise themself with the access level control presently used and shall follow suit.

The user shall be able to carry out any of the following commands by use of dedicated function keys on the keyboard and by single mouse-click. Where possible all existing function keys shall be replicated

- ON (Digital Points)
- OFF (Digital Points)

- AUTO (Analogue and Digital Points)
- SET TO VALUE (Analogue Points)
- ALARM REVIEW
- POINT TYPE REVIEW
- POINT GROUP REVIEW
- HOURS RUN REVIEW
- GRAPHICS ENABLE
- PRINTER ON/OFF
- LOG ON
- LOG OFF
- HELP

It shall be possible to add new points or reconfigure and modify existing points without taking any part of the system off-line. All equipment shall be addressed by using clear language descriptions as well as tags. The tags to be used shall be agreed between the Supplier, Client and Engineer prior to installation. The use of tags alone shall not be acceptable. The supplier shall liaise with all other suppliers and mechanical specialists to ensure that the address values are reflected on all "As Build" drawings.

(F) Alarm

The alarms shall be configured to match the existing. Alarms shall be configurable by the user as to whether or not they are to be printed on a printer allocated. The printout shall contain the address, alarm priority, state or nature of the alarm and time and date of the occurrence.

All the information produced during the alarm cycle, including acknowledgement and clearing, shall automatically be recorded to the fixed disk for historical purposes.

Alarms shall be inhibited to allow for start up of plant or to make allowance for fluttering contacts and slow internal responses. The inhibit function of the alarms shall be user configurable. It shall be possible to select time periods for the inhibits and may be applied when entering into alarm, out of alarm or both.

Alarms shall be handled by the Alarm Handler and shall also be displayed on the Front End Controller using the alarm review function.

(G) STATUS MONITORING

The system shall monitor the status of plant via volt-free contacts from the motor, internally in the panel or from differential pressure switches mounted on the various items of plant.

a) The user shall have the option of receiving alarms on change of state or not.

b) The system shall have the capability of automatically totalising the hours run of the plant.

c) The system shall be capable of setting three alarm limits on hours run totals of each point and output a maintenance message on the pre-set total being reached.

(H) ANALOGUE MONITORING

The system shall continually monitor all analogue points such as temperature, pressure, relative humidity, etc. and display the current data on operator request.

The data displayed shall be in the Engineering units of the measured variables, °C, %RH, Pa, etc.

It shall be possible to set an alarm window of high and/or low limit alarms. When the measured value exceeds the limits an alarm shall be displayed. A double window alarm shall also be provided, thus the inner window may represent a less critical alarm, and the outer a high priority alarm.

It shall be possible to reference analogue alarms to command points to override the time or duty cycling programmes to preserve low limit temperature and provide for frost operation of plant.

There shall be at least 4 No. user configurable set points available for each analogue input signal.

(I) ENERGY MANAGEMENT

The energy management part of the software shall be set up to include the following functions:

I1 Automatic Control Modes

There shall be no limit to the number of time schedules each of which can have any point or number of points assigned.
Each time programme shall operate over a seven day week and allow for up to 35 on/off periods. There shall be no limit to the number of holiday schedules to which any time schedule or number of time schedules may be assigned. It shall be possible to programme holidays 365 days in advance.

I2 Optimum Start Control

There shall be no limit to the number of optimum start schedules to which command points can be assigned. The system shall, by monitoring outdoor air and space temperatures start the plant at the latest possible time to achieve the desired internal temperature by target time. This shall operate in a Heating or Cooling Mode or a combination of both.

The Optimiser Programme shall be self-adjusting the amount of adjustment being operator defined between 0% and 100%.

The operator shall have the option of defining the termination of plant run-up or boost on target temperature being achieved, target time being reached, or whichever first.

Each of the Optimum Start schedules shall have the ability to assign Optimum Stop parameters. As with the optimum start, the system shall be self adjusting on optimum stop.

The following reports shall be available once configured:
Report at commencement of run up.
Report at termination of run up.
Report at commencement of run down.
Report at leaving time
Report at premature run down

Report of Low Temperature Stop/Start
Report at start of occupancy.

I3 Anti-Condensation & Frost Protection Control

During plant off times the space and outdoor temperature shall be continually monitored. When the temperature falls to a pre-set low limit, the plant shall start to prevent formation of condensation or water freezing.
It shall be possible to set the differential between plant on and plant off temperature under these conditions.

I4 Maximum Demand Control

The system shall be capable of monitoring the rate of power consumption through 4 to 20 mA outputs from CTs and kWHr meters and shall take corrective action to avoid high penalty charges by shedding electrical loads when the pre-set demand level is projected to be exceeded. These loads will be advised by the client at a later date.
There shall be a minimum of 8 levels of priority for loads available to be shed. The order of priority in each level shall be rotated to prevent any single load in a priority level from always being shed first.
A log shall be available to monitor the consumption profile over each demand period.
The system shall employ a floating demand set point which will adjust by a set percentage until the optimum set point is determined.

I5 Load Cycling

The system shall be capable of cycling loads to reduce electrical consumption.
The programme shall have an operator defined minimum on time, minimum off time and maximum off time. A temperature detector shall be assigned to each plant on the load cycling programme. Should the space temperature exceed pre-set limits the load cycling shall be overridden and the plant returned to the time control programme until the space temperature has returned to an acceptable level.

(J) INTEGRATED CONTROL

The system shall be capable of performing proportional control, integral control, derivative control or any combination of the three utilising direct digital control techniques.
The input to a control loop shall be either a measured value (ºC, %RH, etc) or a calculated value. In any case, both the measured and calculated values for each point shall be displayed on the graphics interface.
The set point of any control loop shall be capable of being adjusted by time, event, user intervention or as a result of a calculation.
It shall be possible to reference a number of control loops to the same primary input point to achieve multistage control. Where a step controlled output is utilised, it shall be possible to rotate the order in which the steps are switched by time, or as the result of a calculation.

(K) AUTO POWER UP

The system shall sequence the reinstatement of plant after a power failure in accordance with a re-acceleration sequence which shall be supplied to the Supplier at a later date.
When the standby generator is in operation, the system shall limit the number of plant in operation. The number and type of plant shall be the non-critical type and shall be confirmed with the Engineer before programming of the system commences.

(L) LOGGING

It shall be possible to log the status or value of system points or groups of points at regular time intervals or on change of state, and store this information for a pre-defined time interval. It shall be possible to archive this information for future reference.
In the case of timed interval logs, then it shall be possible to specify a time interval (in minutes) and the points which it is required to log. In the case of an event log, then it shall be possible to specify which events are to be logged.

- Digital input point change of state
- Point reports

It shall also be possible to specify the length of time for which logged information is to be stored. A warning message should be produced as logged data reaches 80% of dedicated logging directing capacity to provide the operator with the opportunity of archiving this information. The logging files shall be stored on the PC hard disk.
The data produced by the logging facility shall be printed in tabular or graphical form. Detail logging shall be done for all meters, i.e. water, gas and electricity.
The data shall be presented in tabular form indicating daily, weekly, monthly and annual consumption figures per meter.
The Supplier's attention is brought to the fact that the logging of all events and data by the BMS and all historical trends and records created by the BMS software are in full compliance with the requirements of the Federal Drug Administration (FDA) Regulations 21 CFR, Part 11. The Supplier shall provide a written statement with their tender showing how their software complies with the 21 CFR 11 Regulations.

(M) SYSTEM SPARE CAPACITY

The supplier shall allow in both the BMS system as well as the MCC Panel a spare capacity of thirty percent. Spare Input and Output points shall be fitted and wired to the terminals, and labelled as such.
For circuit breakers only 10% free capacity has to be fitted with space for the remaining 20%. Fitted Circuit breakers shall be pre wired to the terminals

(N) DRAWINGS & SPECIFICATIONS

Upon acceptance of the tender, and prior to manufacturing the supplier shall furnish to the engineers the following, for approval:

- Schematic Diagrams for each panel.
- Dimensioned Layout Drawings for each Panel to include plan and elevation.
- Single Line Diagram of Proposed Network.
- Layout Drawing of each remote Outstation.
- Sample Drawings of Proposed Graphics Interface.

(O) FIELD WIRING

Wiring to the field devices shall be done by the electrical specialist in Belden 9402 or PVC insulated cables. The type to be used shall be agreed with the Engineers prior to installation.
The electrical specialist shall terminate the cables at both ends and be responsible for the testing of the cables.
The supplier shall allow in their tender for attending site to advise the electrical specialist of the technical and wiring requirements of the equipment. The supplier shall also issue to the electrical contactor two copies of a schematic wiring diagram for each of the panels, prior to delivery of the panels to site.

(P) FIELD DEVICES

Field Devices to be supplied and installed under this contract as specified elsewhere. The Mechanical specialist, shall be responsible for installation of the various devices and shall also be responsible for the erection of the MCC Panels.

The BMS supplier shall allow in their tender for attending the site to advise the mechanical specialist of the technical and installation requirements of the field devices and MCC Panels.

(Q) LOCATION OF MCC PANELS

The location of the MCC panels shall be as indicated on the relevant drawings. The Supplier shall take note of the space constraints and design the panel layouts accordingly. The supplier shall ensure that the panels fit into the space provided.

The supplier shall further note the route to be taken to the MCC Panel Position. Should dismantling of the panel and re-assembly on site be necessary, the supplier shall allow in their price for this.

(R) CLIENT TRAINING AND INSTRUCTION

The supplier shall allow in their tender for 2No. full days of client training and instruction, which shall include a classroom and practical type instruction in the workings of the system. The client shall nominate a date and number of attendees for the instruction sessions. The training shall include for both hardware and software training.

10.3 CONTROL DEVICES

General

Controls devices shall bear the manufacturer's name, part number and shall be supplied complete with technical data sheet containing the following information:-

Ambient shortage limits; ambient operating limits; dimensions; weight; housing/terminal box materials; cable entry/conduit entry; protection 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.

Controls devices shall be suitably rated to operate safely and reliably in the environment in which they are to be installed.

Samples of all types of room-mounted equipment (e.g. detectors, thermostats) shall be

provided for approval by the Architect.

Controls devices requiring extra-low voltage, e.g. 24V, shall be provided complete with power supply units/transformers by the controls subcontractor.

All 230V/low voltage controls devices shall be suitable for normal ESB voltage fluctuations.

Devices
Controls devices shall have the following characteristics:-

Room Thermostats
Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of ± 1˚C.
An integral accelerator/anticipator.
Double insulation.

Duct Thermostats/Frost Thermostats
Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An Accuracy of ± 2˚C.
An averaging capillary of suitable length to ensure accurate operation.

Immersion Thermostats
Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of ± 2˚C.
A ½"BSP pocket of minimum length 100 mm.
Concealed setting adjustment.

Safety Thermostats
Voltage rating of 230V A/C 50 Hz.
SPDT changeover contact with 10 amp AC1 rating.
An accuracy of ± 2˚C.
Concealed setting adjustment.
Manual reset type.

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 ¼" O.D. copper tube.

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.

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.

Current Switches
Voltage rating of 30V AC/DC.
Normally open solid state contact 0.1 amp rating.
Require an external power supply (sensor power induced).
No adjustable set point ± 1% of range.
'Switch operated' LED.
Suitable for panel mounting and fixing to base-plate of panel.

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

Humidity Sensors
Operable on a 24V AC/DC power supply.
Either a 0-10V DC or 4-20 mA output.
An accuracy of ± 3% over working range.
Capacitance type sensing element.
Not require regular maintenance, recalibration or regeneration.

Temperature Sensors
NTC type thermistor or active transmitters.
NTC type thermistor with minimum resolution of 25 Ohms/°C over working range.
An accuracy of ±0.3°C over working range.
Not require regular maintenance, recalibration or regeneration.

Pressure Sensors
Operable on a 24V AC/DC power supply.
Either a 0-10V DC or 4-20 mA output.
An accuracy of ± 3% over working range.
Not require regular maintenance, recalibration or regeneration.

Damper Actuators
Spindle passing through actuator and secured by a U clamp.
Each damper actuator to drive not more than 4.0m^2 of damper area
Modulating actuators to operate on a 24V AC/DC power supply.
On/off actuator - mains operated with limit switches.

10.4 CONTROL VALVES

The specialist supplier shall be responsible for sizing and selecting control valves based on information provided by the Mechanical specialist.

Lift and lay (plug and seat) valves shall be used at all heater battery/heat exchange applications. Rotary shoe (slipper) valves are not acceptable.

Valves up to and including 50 mm shall have ends screwed to BS 21 and valves 65 mm and over shall have a cast iron body and flanged end connections.

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.

Let by/leakage rate shall not exceed 0.5% of full valve duty.

Valves shall be sized to give an authority in the region of 0.5 and shall never be less than 0.3.

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.

Valves used on heater battery/heat exchangers shall have a stroke of not less than 20 mm with the exception of terminal unit valves.

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 valves are not acceptable with the exception of terminal unit valves.

Valves used on heater battery/heat exchangers shall have a minimum close-off pressure rating of 1 bar.

Valves shall be fitted with valve position indicators clearly marked to show the fully open and fully closed positions.

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.

10.5 MOTOR CONTROL AND STARTER PANELS

General

Mechanical services panels with main isolator up to 250A shall comply with the following specification. For larger panels, the specialist supplier shall refer to the Electrical Services Specification (Low Voltage Switchgear).

Unless otherwise indicated, mechanical services panels with main isolator up to 250A shall be 'Form 3B Type 2' and shall have the following sections:-

- Protective device.
- Busbar section.
- Starter section.
- Terminals section.
- Controls section.

Motor control and starter panels shall comply with IS EN 61439: -1 2011, IS EN 60947 and relevant ETCI codes of practice, as appropriate. Panels shall provide the IS EN 60947-1 degree of protection indicated. Unless otherwise indicated, internal compartments shall be to IP40. All MCC panels must display on the front of each panel Certified Short Circuit Rating, Switch Gear Assembly Rating, and equipment specification.

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. 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.

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.

Unless otherwise indicated, the assembly shall include 25% spare capacity on busbar and cabinet size.

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.

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.

The following spares and accessories shall be supplied with each assembly where applicable:- 2 cubicle access keys; 2 fuse withdrawal tools where N.H. style cartridge fuses are used; 3 spare fuses of each rating and type used in the assembly; 12 spare bolts used for fixing cubicle side and back cladding; 25 cl. tin of touch-up paint; 6 label fixing screws; 2 lenses of each colour and type for indicator lamps.

Materials and Construction

The panel enclosure shall be rigidly constructed from suitably prepared and finished best quality folded mild steel sheet of a minimum thickness 2 mm or of mild steel angle frame supporting sheets of a minimum thickness 1.2 mm, or be a proprietary system of construction to the approval of the Engineer.

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.

Doors shall be flush-fitting mild steel with folded edges and welded corners of a minimum thickness 2 mm with concealed non-ferrous hinges, or of alternative construction to the approval of the Engineer. Framework associated with doors shall be fitted with skinned foamed plastic dust protective strip or neoprene tube sealing gaskets.

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.

Panels shall be finished externally with a full- or semi-gloss stove-enamelled finish to BS colour of Architect' choice. Internal surfaces and component mounting plates shall have a matt white finish. All surfaces shall be properly prepared before final finishing.

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 builder's work base. All panels shall be provided with fixing holes. Large panels or panels exceeding 75kg shall be provided with detachable lifting eyes.

Heat generating devices such as starters, transformers, relays, etc. shall be mounted on D.I.N. rail with adequate spacing between each unit. End stops shall be

provided on all devices.

Panel Wiring

Internal power wiring shall be identified by colour code in accordance with relevant ETCI Wiring Regulations. Control circuit and other wiring shall be to the appropriate ETCI Wiring Regulations with identifying code extending to each cable termination using ferrules or other approved permanent means of attachment. Secure fixing of all cable ends shall be ensured by the use of purpose-made clamps, pinch-type terminals, crimped cable tags or other approved termination devices.

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.

Fuses shall comply with the requirements of BS 88 : 1988 and shall be grouped and mounted so as to be readily and safely accessible.

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.

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.

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.

Identification Labels

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 : 2000 AMD1 : 2004 shall be provided.

Ventilation

The temperature rise in panels shall not exceed the limits stated in IS EN 60439-1: 2000 AMD1 : 2004. 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 100C above ambient.

Instruments and Indication

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.

The colours and colour significance of indicator lamps shall be in accordance with IS EN 60073 : 2002, unless otherwise indicated. Where extra low voltage filament lamps are installed, they shall be fed from a double-wound transformer complying with IS EN 61558. Permanent legible information shall be provided adjacent to each indicator lamp to readily identify its function.

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.

Indicator lamps and instrumentation shall function with selector switches in the 'HAND' or 'AUTO' position.

Indicator Lights

Indicator Lights shall be fitted to the façade of the Panel to indicate Run, Trip and other signals.

The lamps shall be of the clear glass type with a 24V filament.

The construction of the lights shall allow for the replacing of the lamps without disconnecting or dismantling the panel. The supplier shall also allow for a Lamp Test facility on each panel. The lamp test shall be by means of a single push-button which, when operated, will light up all lamps irrespective of the equipment status.

Lights shall be installed to indicate the following conditions:

i. Pump/Fan Running (Green)
ii. Pump/Fan Trip (Red)
iii. Mains Supply Healthy (Orange)

Starters and Control Gear

Unless otherwise indicated, starters shall comply with IS EN 60947-4-1, -2 and -3. The 'rated duty' shall be 'intermittent' and the class of intermittent duty of the starter shall be appropriate to its operating conditions.

The following types of starters will be accepted unless otherwise indicated:-

Motors up to 0.75kW output, 230V, single-phase: direct-on-line.

Single-speed motors over 5.5kW output, 400V, three-phase: star-delta or soft-start.

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.

Multi-speed motors with independent windings shall start on the low speed winding.

For starters incorporating reduced voltage starting, the changeover of voltage shall be automatic. All reduced voltage starters shall have an adjustable transition line.

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.

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 MECHANICAL CONTROL PANELS

MCC (Located in external plant)
Function: wall mounted control panel with BMS outstation supplying power, control and monitoring of new plant installed throughout the building. Refer to drawing 5900 SERIES for details of plant to be wired.

The mechanical specialist shall forward to the Engineers a full and complete BMS points list associated with the entire BMS installation, this document shall be submitted well in advance of works proceeding

Pump Control and Monitoring (Twin Head Circulation Pumps)

These pump-sets are operated on a Run/Standby basis. The pump-set is enabled by a BMS Time Schedule, which is accessed through the graphics. The Time Schedule shall have the facility for up to ten on/off periods per day (standard week) and can be programmed in advance for assigned dates (exceptions). Changeover from 'Run' to 'Standby' occurs weekly, at midnight on Sunday. The run status of each pump is monitored by a current switch, which is monitored by the BMS.

If a pump fails to run when requested then a fault alarm is generated by the BMS and the alternate pump is enabled. The fault is manually reset through the BMS graphic. If a pump trips on thermal overload then the alternate pump is enabled, through hard wiring.

All pump-sets are also enabled by the BMS using input from:
- Immersion Frost (hard-wired)
- Outside Frost (hard-wired)

The pumps are disabled by the BMS sensing:
- System Low Pressure
- Fire Alarm
- Outside temperature hold (off adjustable from the BMS graphic)

Heating Circuit Temperature Control

The LPHW heating circuits shall be controlled via a Compensator on the BMS which shall send a signal to the boiler sequential control panel which shall control the output

temperature of the boiler(s) giving direct weather compensation of the flow to the low temperature low loss header. The BMS shall monitor Water Temperature via an Immersion Temperature Sensor mounted in the Flow pipework, Outside Air Temperature via the Outside Temperature Sensor. The Compensator Origin and Slope Setpoints shall be user adjustable and programmable via the BMS.

System Pressurisation

The System Pressurisation High and Low Pressure Cut-outs are Hardwire Interlocked with the Boilers and Pumps. On a Low Pressure condition the Pumps and Boilers are disabled. On a High Pressure condition the Boilers are disabled and the Pumps remain running to dissipate the High Pressure condition. The BMS monitors both High and Low Pressure conditions. Activation of the system low-pressure switch generates an alarm in the BMS. System High-pressure switch activation also generates an alarm in the BMS.

Frost Protection

If the outside temperature falls below 2'C then the Outside Frost Thermostat is tripped and all pump-sets are enabled to run. This control is by means of hard wiring.

If the boilers return temperature falls below 5'C. Then the Immersion Frost Thermostat is tripped and all pump-sets and all boilers are enabled to run. This control is by means of hard wiring.

Water Metering

The BMS continuously monitors the pulse from the new water meter on the main water incomer for the new building, which will be located in the new plantroom. A BMS graphic shows the daily usage of each meter for each day of the week and a monthly usage of each meter for each month of the year.

Electricity Metering

The Electricity Meters transmit power usage in kWHrs, Voltage and current Amps to the BMS. The total value for each meter is displayed on the graphic and also data-logged to record kWHrs used over a period of every 15 minutes.

Data Logs

The BMS controllers shall be set up to log all Analogue Input Points and all Analogue Output Points at 900-second intervals. Data Logs can be archived on a daily basis on the Hard Disk of the BMS Terminal. It is the BMS operator's responsibility to decide which data logs are archived.

10.7 TESTING AND COMMISSIONING

General

The specialist supplier shall provide all test equipment and hand-held radio transmitters required for all stages of testing, commissioning and demonstration. Recent calibration certificates must be provided for all test equipment used.

Final Wiring Connections

The specialist supplier shall be responsible for checking all wiring and making-off of final connections at outstations, user-interface, panels and all field devices.

All screened cables shall be earthed at one end only at the control panel; at the field device the screen shall be cut back and insulated.

Pre-Commissioning/Testing

The specialist supplier shall be responsible for pre-commissioning and testing. At this stage of the works, the specialist supplier shall examine all wiring and connections on the system in order to ensure that no damage will occur to any equipment (whether provided by the specialist supplier or not).

The exact method of testing shall be the responsibility of the specialist supplier.

The specialist supplier shall supply signed test sheets for all equipment connected to the system.

Input/Output Testing

The specialist supplier 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 specialist supplier shall supply signed sheets for these tests.

Operational Testing

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.

Acceptance Demonstrations

The specialist supplier shall demonstrate the following in the presence of the client's Staff and the Resident Engineer:-

- Every point on the system including calibration checks.
- All dynamic graphics.
- All system programmes.

Unless otherwise indicated, the specialist supplier shall allow for 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.

Provisions shall be made for video recording of training sessions where indicated.

10.8 RECORD DOCUMENTATION

The preparation, completion and issue of record documentation by the specialist supplier shall comply with the **relevant section** of this Specification.

Controls systems record documentation shall include, but is not limited to, the following:-

- As-commissioned MCC drawings
- As-installed network drawings
- Commissioning test sheets

- Points listing
- Equipment data sheets
- System operational description
- Controller operator's manual
- Setting sheets
- Suggested spares lists
- Maintenance proposal
- Completion certificate

Front End Equipment

The Supplier shall allow for the supply and installation of the following in each site:

Laptop

The Supplier shall allow for the supply of 2No. Laptops to be used as a remote, mobile interface to the system. The Laptops shall be supplied complete with interface cables, BMS Software. The Laptops shall be equipped with (minimum):

- 2.7 GHz Intel Core i7 Processor
- Windows 10 Operating System
- 1TB Hard Disk.
- CD & DVD R/RW DRIVE.
- 8GB RAM
- 17.3" Display capable of supporting HD graphics.
- Two USB 3 ports
- Network card and for internet connection
- HD Video/Graphics Card

Printer

The Supplier shall allow for the supply of a Colour Inkjet Printer capable of printing A4 size pages. The printer shall be equal and similar to the HP DeskJet 1220C and shall be supplied complete with cables and driver software and three sets of new, unopened printer cartridges.

11 INSPECTION TESTING AND COMMISSIONING

11.1 GENERAL

Client's representatives will be present for the start-up of all major equipment, such as air handling units, boilers, chillers, generators, UPS and automatic control systems.

Certified Testing and Balancing Specialist will test, adjust, balance and commission systems resulting in proper operation of individual pieces of equipment and also the proper operation of the overall HVAC and plumbing systems, in accordance with CIBSE Commissioning Codes A, B, C, M, R, other applicable Guidelines and ETCI Regulations.

Performance testing of all equipment and systems including chillers, boilers and other systems for part load and full load during summer, winter, spring and autumn seasons will be demonstrated to validate system performance.

The Mechanical specialists shall be responsible for commissioning the entire mechanical and electrical services for all phases and stages of the installation to the satisfaction of the Engineers. The Mechanical specialist shall produce for the approval of they Engineers a detailed specification for commissioning Procedures for the completed installation. This Specification shall be provided well in advance of the commissioning programme and at a time agreed with the Main Contractor.

The Commissioning Procedures Specification shall include the following:

(a) Detailed operating programme.

(b) Bar chart showing weekly analysis of programme.

(c) Data to be used for each stage of commissioning.

(d) Detailed commissioning schedules for each item of plant and equipment.

(e) Requirements and involvement of Consulting Engineer and Facilities Management Staff.

(f) Method of logging all performance data with processing and issuing to Clients representatives.

(g) Method of issuing certificates including suppliers certificates.

(h) Instruments and method of measurement to be used in commissioning.

(i) Instructing Staff in use of plant and systems.

The Mechanical specialist shall co-ordinate with the respective Mechanical/Electrical specialist in arranging a seminar to present and explain the commissioning methods and programme they proposes for the installation. They shall also arrange for all specialist suppliers/installers involved in the mechanical/ electrical installation to be in attendance to outline their own commissioning procedures.

The Mechanical specialist shall supply sufficient lubricating oil and other consumable materials to allow the complete commissioning and testing of the equipment within their scope.

The Mechanical specialist shall refer to the General Conditions for details of the attendance being provided within the programme period agreed at the commencement of works.

The Mechanical specialist shall be responsible for ensuring that tests by nominated suppliers are properly carried out.

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.

The Mechanical specialist 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.

Unless otherwise indicated, the Mechanical specialist shall give a minimum notice of 7 days prior to all tests, on or off site, in order that the Engineer, at their discretion, may be represented at such tests. Both the Mechanical specialist and the Engineer's representative shall sign the test certificates which shall be prepared by the Mechanical specialist and retained until completion of the works.

The Mechanical specialist 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.

11.2 INSPECTION

Throughout the execution of the works, the Mechanical specialist 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.

All plant equipment and system components shall be installed, adjusted and set in accordance with the manufacturer's instructions.

Where an inspection is required by an authority other than the Engineer, the Mechanical specialist shall inform the Engineer of the place and date fixed for such inspections.

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 Mechanical specialist from full responsibility for the quality and correctness of their work.

CLEANLINESS

All systems shall have been cleared of any obstruction and cleaned externally and internally before commissioning and testing.

Pipework Distribution Systems

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.

All water distribution systems shall have been thoroughly flushed and cleaned as part of pre-commissioning in accordance with CIBSE Commissioning Codes.

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.

Effluent from cleaning processes shall be disposed of in compliance with the requirements of the local Water Authority.

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.

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.

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 CIBSE Commissioning Codes.

Unless otherwise indicated, heating and chilled water pipework shall be chemically cleaned in accordance with CIBSE Commissioning Codes.

Water services systems shall be flushed, cleaned and disinfected as required in accordance with BS 6700 : 1999 and BS EN 806-1 & 2.

Ductwork Distribution Systems

The mechanical specialist shall be responsible for installing the ductwork to the 'advanced level' as defined in the HVCA's (2005) 'TR/19- Guide to good practice:Internal cleanliness of ventilation systems'. This specifically includes ensuring that ductwork sections arrive on site and are stored with their open ends sealed and that open ends remain sealed during installation to prevent the ingress of builders dust. Should any doubt exist as to whether the guidance has been implemented and the level of duct cleanliness of the installed system, the mechanical specialist shall swab/clean out all ducting to restore same to this standard, at no additional cost. Sufficient ducting access sections must be installed to facilitate duct cleaning, refer to relevant clause in specification for further details.

Unless otherwise indicated, the Mechanical specialist shall provide a certificate confirming that the procedures outlined above have been carried out and the cleanliness level achieve inline with TR 19.(HCVA0 SW/TM2)

11.3 NON-DESTRUCTIVE TESTING

Welds 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:-

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.

The acceptable limitations in faults revealed by non-destructive testing shall be as specified in HVCA TR/5, BS 2971: 1991 or BS 2640: 1982, as appropriate.

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 until such time as a satisfactory standard is reached.

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 13.4 below, 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.

11.4 PRESSURE TESTING

The Mechanical specialist shall ensure that any item which is not designed to withstand the test pressure is not included in pressure tests. In addition, the Mechanical specialist shall ensure that pumps, filters, tanks, and other items of equipment are excluded from pressure tests.

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.

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.

After being cleaned, manufactured and natural gas installations shall be tested for soundness and purged in accordance with the requirements of IS 820.

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.

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.

Fire protection installations shall be tested in accordance with BS 5306, as appropriate.

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.

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.

11.5 COMMISSIONING

The Mechanical specialist 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.

The entire commissioning procedure shall be undertaken by the Mechanical specialist's specialist staff or by a competent independent commissioning specialist nominated by and acting for the Mechanical specialist. The Mechanical specialist must obtain the Engineer's approval of the commissioning specialist.

The Mechanical specialist shall submit samples of the commissioning specialist's test sheets to the Engineer for comment. TM3 Test sheets available from the commissioning specialist association (CSA) are preferred.

Unless otherwise indicated, the Mechanical specialist shall submit a commissioning schedule and programme to the Engineer at least 6 weeks before commencement of commissioning.

Commissioning shall include:-

Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start-up as detailed previously.

Preliminary setting and adjustment of all plant and equipment consistent with eventual design performance.

Energising and setting to work of all plant.

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.

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.

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 Mechanical specialist and endorsed by the Engineer.

11.6 PERFORMANCE TESTING

Where indicated, the Mechanical specialist 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 themself 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 Mechanical specialist's expense.

11.7 DEMONSTRATION AND HAND-OVER

The Mechanical specialist shall include for the requisite man-hours for the demonstration, instruction and hand-over of the mechanical services installation to the Employer. A minimum period of four hours is to be included for training of client staff in the operation of plant and equipment.

The Mechanical specialist shall ensure that record documentation is handed over to the Employer two weeks prior to demonstration.

11.8 COMPLIANCE WITH BUILDING REGULATIONS

The mechanical specialist will be responsible for the mechanical works to be installed in accordance with the current building regulations. Before final handover the mechanical specialist will issue a certificate of compliance for their installation in accordance with the building regulations.

11.9 MAINTENANCE AND EQUIPMENT

The mechanical specialist shall allow for maintaining all of the equipment supplied and installed under the mechanical contract for a period of 12 months after practical completion of the building to coincide with the warranty period for the works. The maintenance works shall include all consumables required by the equipment during this period with the exception of gas and electricity. The mechanical specialist shall maintain the equipment for the twelve months strictly in accordance with the manufacturer's requirements for each item of plant. The mechanical specialist shall provide a detailed list of maintenance schedules (monthly, quarterly, yearly etc.) and consumables for all plant requiring maintenance during this period, including the necessary consumables required.

12 HEALTH, SAFETY & WELFARE AT WORK (CONSTRUCTIONS) REGS 2013

12.1 PROJECT SUPERVISORS

12.1.1 The client has appointed Project Supervisor for the Design Stage of the Project to carry out the duties set out in Article 4 of the Regulations.

12.1.2 The Main Contractor shall be appointed by the client under a collateral agreement to the main contract as Project Supervisor for the Construction Stage in respect of the project pursuant to the Safety Health and Welfare at Work (Construction) Regulations 2006 & 2013 amendments. The contractor shall include all costs for the provision of the services of Project Supervisor for the Construction Stage pursuant to Regulations 6 and 7 of the Regulations.

12.1.3 The Contractor shall include for providing all necessary information as requested by the Project Supervisor for Construction Stage to enable the preparation and completion of the Safety File excluding drawings and specifications which shall be provided by the appropriate member of the design team and relevant nominated sub-contractors.

12.1.4 The contractor shall include for providing assistance to the appropriate member of the design team (and to relevant nominated sub-contractors) in preparing "As Built" drawings for inclusion in the Safety File.

12.1.5 The Client will appoint the Main Contractor as Project Supervisor for the Construction Stage of the Project, to carry out the duties set out in Article 6 of the Regulations.

12.1.6 The Contractor shall include in their tender for complying fully with the Health, Safety & Welfare At Work Act and The European Council Directive 92/57/EEC.

12.2 CO-ORDINATION OF PERSONS ENGAGED IN THE DESIGN OF THE PROJECT

12.2.1 In accordance with Article 4(1) (a) of the Regulations, it is the duty of the Project Supervisor for the Design Stage to co-ordinate the activities of persons engaged in the design of the Project.

12.3 DUTIES OF NOMINATED SUB-CONTRACTORS AS DESIGNERS

Preliminary Health & Safety Plan

12.3.1 To enable the Project Supervisor for the Construction Stage to develop the Health & Safety Plan for the project, it is necessary for the Mechanical Contractor to give the information which is relevant to the requirements of the Regulations in relation to that part of the works for which they/she is tendering.

- A general description of the works.
- The time in which it is intended that the works will be completed.
- Work which will enable Particular Risks as defined in Schedule 2 of the Regulations.

12.4 GENERAL DUTIES AS DESIGNERS

12.4.1 Where a sub-contractor designs any element of the works as part of their contract, the nominated sub-contractor has a statutory obligation to perform the duties set out in Article 5 of the Regulations in relation to those parts of the works. These are:

1. Take account of the general principles of prevention as specified in First Schedule of the Principle Regulations (S.I. 44 of 1993) and any relevant Safety & Health Plan or Safety File prepared in accordance with the Health, Safety and Welfare at Work (Construction) Regulations 2013.

2. Co-operate with the project supervisor appointed for the design stage or the project supervisor appointed for the Construction Stage, as appropriate, to enable that project supervisor to comply with these regulations.

3. Promptly provide the project supervisor appointed for the design stage, or the project supervisor appointed for the construction stage as appropriate, with such information as is known to that person regarding particular risks to the safety and health of persons at work as referred to in the second schedule which may be associated with the project and also with such information regarding the nature and scope of the project to the extent necessary to enable the project supervisor to comply with these regulations.

4. Take into account any directions from the project supervisor appointed for the construction stage as appropriate.

It should be noted that under (3) above, the Mechanical Contractor is required to provide copies of the following documents to the project supervisor for the constructions

12.4.2 Drawings showing the installation as constructed.

12.4.3 Details of the construction or installation including manufacturer's instructions for the installation of proprietary elements, pipe layouts, wiring routes and diagrams.

12.4.4 Full instructions for the safe maintenance of the construction or installation.

12.5 MECHANICAL CONTRACTOR TO CHECK ALL MATTERS

12.5.1 The Mechanical Contractor is to examine the site and the information supplied regarding the nature and extent of the proposed works, so as to be satisfied as to what is required to be done to fulfil the duties in relation to the design and preparation of the works and also what measures are required to be taken to meet the requirements of the Regulations in the execution of the works. All costs arising in respect of these obligations are to be included in the tender figure and the Client will not be liable for any such costs which are reasonably foreseeable and which are not so included.

13 EQUIPMENT SUBMISSION PROCEDURE

13.1 INTRODUCTION

It is the responsibility of the Mechanical Contractor to ensure all submittals have been submitted, and signed off by all parties prior to placing orders with suppliers/manufacturers.

All technical submittals should be sent electronically to the Engineer accompanied with the following as a minimum:

- Confirmation of the life expectancy (must be compliant with CIBSE Guide M, Appendix A.13).
- Full Technical details for the submittal.
- Proposed Manufacturer.
- Proposed installer.
- Details of technical support in Republic of Ireland.
- Details of previous project undertaken of similar nature.
- Confirmation that systems will be installed and certified in accordance with the works requirements and the relevant standards (I.S./B.S. / E.N. / ETCI etc.).
- An up to date submittal tracker schedule

The contractor must provide technical submissions for all systems and equipment that is proposed for comment (status A, B, C) by the Engineer. These shall be presented a minimum of eight weeks in advance of the respective equipment, services being required for services co-ordination purposes.

These submissions shall cover all aspects of the works. Details of Specialist installations should be included in the tender submission documents. The purpose of the submissions is to allow the contractor to demonstrate compliance with the Works Requirements.

A review of the submissions by the Engineer does not constitute any approval of the systems and equipment being proposed. It is the responsibility of the Contractor to comply in full with the Works Requirements and whether submissions are reviewed, or not, or commented on, or not, does not relieve the Contractor of their responsibility to comply with the Works Requirements. Where items or installations are subsequently found at any stage to be not in compliance with the Works Requirements, the Contractor shall rectify the works at their own expense.

In addition to the above, the submissions shall be provided in a timely manner to suit the programme of works. A maximum of two Technical Submissions shall be presented in any one working week to allow review by the Engineer. The contractor is required to submit a programme in their Tender Submission of when each technical submittal shall be presented for review by the Engineers. The Engineers shall endeavour to comment on each technical submission within 10 working days of receipt of the submissions; however failure to present this programme in the tender submission or to adhere to the programme may result in delays in any comments presented by the Engineers. The Engineers shall not be held responsible for any delays in the contractor's works due to late receipt of technical submissions for review.

The submissions shall be structured to the respective systems within the building.

Separate submissions shall be presented for all services materials and equipment, including the following:

- All items of plant and equipment
- Soils & Waste Installations
- Water Services Pipework Installations
- Heating Installations Pipework Installations
- Circulating Pumps

- Water Storage Tanks
- Air Source Heat Pump
- Ductwork Installations
- Extract Fans
- Fire and Smoke Dampers
- Grilles
- Insulation
- Fire Fighting Equipment
- Volume Control Dampers
- Valves/TMV/TRV
- Controls/BMS
- Commissioning Programme
- Co-ordinated Services Drawings
- Builders Works Drawings