MECHANICAL SERVICES
PERFORMANCE SPECIFICATION
& CLIENT'S REQUIREMENTS

For

RECEPTION EXTENSION & ASSOCIATED WORK

at

PINNER PARK SCHOOL
MELBOURNE AVENUE, PINNER
MIDDLESEX HA5 5TL.

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DGA
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SPECIFICATION DOCUMENT CONTENTS – 2007M/JH

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SECTION ONE

STANDARD CONDITIONS

Mechanical Specification Standard Clauses

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1. STANDARD CONDITIONS

1.1 Extent of Specification

The Specification refers to the supply, installation, testing and commissioning and maintenance during the warranty period for the complete engineering building services to be carried out by the Contractor. In the event of a discrepancy and/or contradiction between the Specification and related documents and drawings, the Contract Administrator (CA) will supply such particulars or verify and rectify the discrepancy.

Should the Contractor discover any such discrepancy they shall bring it to the attention of the CA.

Where “Standards of Materials, Workmanship and Installation" is at variance with “Particular Requirements", the Particular Requirements shall take precedence. The contract works shall comprise the complete installation and shall include manufacture, works testing and delivery to site, setting to work, testing and commissioning, provision of records and operating and maintenance manuals for the new and modified engineering building services as specified herein and outlined on the tender drawings.

The contract works shall comprise the whole of the labour and all materials necessary to form a complete installation and such tests, adjustments and commissioning as are described in subsequent clauses and as may otherwise be required to give an effective working installation to the satisfaction of the CA.

Contractors carrying out any electrical installation work shall belong to either or both of the following bodies:

- NICEIC
- ECA

1.2 Visit to site

The Contractor shall visit the site before completing their tenders, and will be deemed to have satisfied themselves on the full nature of local conditions as regard accessibility, transport and storage of materials, the supply of and conditions affecting labour, and to have obtained all necessary information on all matters affecting the execution of the works.

When the works are associated with existing and occupied buildings the Contractor shall make prior arrangements with the person in charge of the establishment before visiting the site. The address of the establishment and telephone number will be found in the supplementary specification.

Claims on the basis of want of knowledge in respect of site condition will not be accepted.

1.3 Definitions

The definitions for words, and phrases associated with the design, manufacture and site works for the mechanical installations shall be those of the IEE Regulations, CIBSE (Chartered Institution for Building Services Engineers) and BSRIA (Building Services Research and Information Association) Guides, British Standards, Codes of Practice, associated Statutory Acts and mandatory authorities.

1.4 Regulations & compliance

All materials and workmanship shall be the best quality in accordance with the standards specified and shall conform to the requirements of the regulatory bodies as given in the specification and contract documents. All materials specified shall be in accordance with the latest British/European Standard Codes of Practice, British/European Standard, and ISO standards (latest amendments),Engineering specification. The whole of the works shall be executed in the most workman like manner. It shall comply with the best practices of the trades and conform in all respects with the current requirements.

The Contractor shall provide certificates or letters stating the materials and installations are in accordance with the authority having jurisdiction over them, the regulations applicable, and the applicable British and ISO standards as follows:

- Asbestos Regulations
- British Standards
- BS 7671 (IEE Wiring Regulations latest amendments)
- BSRIA: Building Services Legislation – a directory of UK & EU Regulations
- Building Regulations
- CDM Regulations
- CIBSE Guides and Technical Memorandum
- Clean Air Act
- Construction Health & Safety and Welfare Regulations
- DfE Building Bulletins
- Disability Discrimination Act
- Electricity at Work regulations
- Environmental Protection Regulations

- Factories Acts
- Fire Officer Committee Regulations
- Gas safety & installation regulations
- Health and Safety at Work Act
- Health and Safety Executive Guidance and Approved Codes of Practice
- Home Office Regulations
- HVCA Standard Specification
- IGEM Publications
- Local Authority By-laws
- Provision and use of work equipment regulations
- Public Health Acts
- Chartered Institution of Building Services Engineers
- Statutory Instruments and any other relevant Acts of Parliament.
- Water Regulations

Should there be any item specified or shown which may be considered as not complying, the Contractor shall notify the CA of this so that dispensation and/or clarification can be obtained. If certificates are not issued by the Authority having jurisdiction then the Contractor shall submit a letter stating the work complies in all aspects to the above standards and regulations.

Any apparent conflicts found between the drawings, the specification and statutory requirements are to be notified immediately in writing to the CA by the Contractor.

1.5 Contractor Design Portion of the Works

Where sections of the works have been specified on performance parameters and the Contractor has selected systems and equipment to meet these performance criteria, the Contractor shall ensure such systems and/or equipment will fully meet the specified performance requirements.

Additionally, the selected systems/equipment shall not be incorporated in such a way as to adversely affect the operation of the rest of the installation. The Contractor shall provide to the Engineer, drawings, calculations etc, to prove his selections for performance specified works. These shall be provided before work commences on site in a reasonable time (minimum 14 days) for comments to be issued.

The Contractor shall not commence ordering materials & equipment or proceed with an alteration until the drawings etc. have been commented upon by the Engineer. These comments will not be unreasonably withheld.

1.6 Schedule of rates and quantities

The Contractor shall on request submit within 14 days a Schedule of Quantities and rates upon which the tender has been based.

The Schedule should detail quantities or rates for all work in accordance with the Standard Method of Measurement current edition. The Schedule shall be fully priced and totalled to the tender price. The schedule will be used for the pricing of variations.

In the event of discrepancy in the Schedule, the quantities and or rates they shall be corrected as necessary, the total sum shall not be amended.

1.7 Instructions and variations

No variation shall be undertaken without written authorisation.

The cost of each variation when requested shall be submitted before the work is carried out. Where permission is granted to proceed with the variation the cost shall be submitted within 14 days.

Where work is carried out as dayworks the cost shall be submitted immediately the variation work is completed.

When materials and equipment not included in the Schedule of Rates are required under a variation, the estimate submitted shall include a copy of any quotation received from the supplier and shall show separately the allowance required for overheads and profit.

The price for a variation or instruction shall include any loss of time, out of sequence working or any effect on the Contractor's programme.

Subsequent claims for anything associated with a variation or instruction will not be accepted.

~~**1.8 Daywork**~~

~~No work shall be carried out at daywork rates without prior written approval. Where daywork is permitted, time sheets signed by the Clerk of Works or other authorized personnel shall be submitted with detailed material schedules to support any claim. Where daywork exceeds one month in duration, time sheets shall be submitted at periods not exceeding one month.~~

~~The signing of daywork sheets by the Clerk of Works or other person will not constitute authorisation of the work.~~

~~The cost of authorised daywork will be calculated in accordance with the current~~

~~Definition of Prime Cost of Daywork carried out under the Building Contract issued by the Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers. The percentage additions are for overhead, profit and those items defined in Section 4 of the above document.~~

~~Labour rates will be those current at the time when~~ the daywork is carried out and will be strictly net JIB for electrical contracting rates and in accordance with the Working Rule Agreement.

1.9 Approval

The specification shall not be varied in any way unless agreed in writing. Where the specification indicates that approval is required for materials, workmanship, products or installation methods, time must be allowed by the Contractor within the construction/installation programme for this approval to be given in writing (14 days).

Adequate time must be allowed for the CA to comment on the proposed alternatives, generally 10 working days unless stated otherwise in the terms of the agreed contract.

1.10 Quality of materials, workmanship & standards

The contract works shall be executed in a neat, substantial and workman like manner and in accordance with BS EN ISO 9000: Quality management and quality assurance standards.
All materials and workmanship shall be of the various kinds described within the specification and shall be subjected from time to time to such tests as the CA may direct at the place of manufacture or fabrication, or on site or at such other place or places as may be specified herein.
The Contractor shall ensure that all materials and equipment supplied are in accordance with all current issues and amendments of relevant British Standards, Specification and Codes of Practice.
The Contractor shall ensure that all electrically powered equipment and materials supplied are suitable for the LV electricity supply available.
Where and to the extent that materials products and workmanship are not fully specified, they are to be suitable for the purposes of the specified works stated herein and the contract documents and in accordance with good building practice, including the relevant provisions of current British Standards and other associated documents.
The execution of the works shall be subject in all respects to the comment of the CA. No approval, comment or acceptance by the CA shall relieve the Contractor of his design responsibilities under the terms and conditions of the contract for the quality of materials and the standard of workmanship provided.
The design, manufacture and installation of all plant, equipment and materials shall comply with all local codes and regulations.
Where any portion of the Contract Works is covered by a British Standard Code of Practice the requirements of that Code are to be complied with unless specifically instructed by the CA in writing in reply to the Contractor's request for a ruling.
The Contractor's attention is drawn to the fact that when enquiring for manufactured materials the manufacturer should be advised of the relevant standards. The consequences of any failure to comply with this requirement shall be the Contractor's sole responsibility.
The Contractor shall be responsible for passing full details to the manufacturers of all materials and shall not assume that the CA has already established the necessary basis for quotations.
Materials used in conjunction with or as part of the installation shall be incapable of spontaneous combustion, nor support combustion once ignited and shall be self extinguishing.
All runs of pipework, cable trays and electrical containment, ductwork, plant and equipment and all accessories shall be truly aligned with each other and the building, plumb or level.
The Contractor shall allow, at no additional cost, for disconnecting and replacing after inspection any item of plant, pipework, ductwork, fittings or accessories which are not installed in accordance with the requirements of the specified standards of materials and workmanship and re-fix the whole or any part of the installation as required by the CA.
Except where specified otherwise, all materials and equipment associated with the installation shall be handled and installed strictly in accordance with the manufacturer's recommendations and shall be handled and installed by workmen who have had previous experience of the equipment and materials and who have, where necessary, attended a manufacturer's course on use and installation.
The Contractor shall ensure that any special tools recommended by manufacturers for the installation of their materials and equipment are used by the workforce.
The Contractor shall demonstrate that his workforce is competent and experienced to carry out the installation work to the standard called for in this specification.
Where applicable the Contractor shall obtain and submit to the CA all manufacturers' guarantees of performance.

1.11 Manufacturer's standards

The inclusion in the drawings and specification of the names of any companies or proprietary items shall read as an indication of the quality, performance and workmanship required. Where manufacturers or companies are specified as Suppliers or Sub-Contractors they shall work within the terms and conditions of the Contract. The tender shall be submitted including materials and equipment by the manufacturers specified.
All materials and equipment shall be suitable in all respects for the site conditions, both in terms of climate and specific location. Conditions under which these items are to be installed must also be taken into consideration. All equipment shall be capable of operating continuously under variation in the supply system of ±10% in the voltage and ±1% in the frequency.
The Contractor may submit alternatives for consideration and these shall be submitted during the design period quoting the alternative

manufacturer, catalogue reference or range without increase of costs to the tender price.
The CA reserves the right to agree to alternative manufactured materials only if they meet or exceed the requirements of the originally specified product. The cost of any redesign would be at the Contractor's expense.
Acceptance of alternative manufactured materials and equipment shall not relieve the Contractor of his contractual responsibilities.

1.12 Samples

Where products or materials are subject of the CA's comments, samples shall be submitted or other evidence of suitability shall be provided. Orders shall not be confirmed or materials used until the CA's comments have been received and approval granted. Approved samples shall be retained on site for comparison with products and materials installed.

1.13 Conditions of Service

The contract works shall be installed to facilitate inspection, cleaning repairs, and for operation in which safety and continuity of services are the first considerations.

All plant and equipment shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing at the site.

The completed installations shall incorporate every reasonable precaution and provision for the safety of all those concerned in the installation, operation and maintenance of the Contract Works.

All materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform. No welding, filling or plugging of defective parts will be permitted without the approval in writing of the CA.

The selection of all plant and equipment must be such that variation may be made to its specified duty on site without major replacements. All plant and equipment shall operate without undue vibration and not exceed the specified noise levels.

In the selection of plant and equipment spare parts must be assured and preference should be given to manufacturers that have local offices and/or agencies that offer a full spares and maintenance service.

Operating boxes, kiosks, cubicles and similar enclosed compartments forming part of auxiliary equipment shall be adequately ventilated to restrict condensation and, where environmental conditions require, suitable integral low-temperature heaters shall be provided. All contactor or relay coils and other electrical parts shall be suitably protected against corrosion.

All externally mounted apparatus shall be so designed as to avoid pockets in which water can collect and shall be weatherproof.

The underside of all tanks and cylinders shall be ventilated in an approved manner to prevent corrosion. Accessible means shall be provided for the easy lubrication of all bearing, mechanisms and moving parts. Grease lubricators shall be fitted with hexagon nipples. All mechanisms shall, when necessary, be constructed of stainless steel, brass or gunmetal to prevent sticking due to rust or corrosion.

All rubbing or wearing surfaces shall be machine faced. Joints employing a gasket material shall be so constructed that the packing is maintained under sufficient compression in all jointing compound. Gasket material shall be of the minimum thickness necessary and of approved composition.

All apparatus shall be designed to obviate the risk of accidental short circuit due to animals, birds and vermin. Openings in ventilated enclosures shall be so constructed to prevent the entry of vermin and insects.

All apparatus incorporating doors shall be erected so that the doors can be opened to at least 90° after adjacent equipment has been installed.

1.14 Supervision

The Contractor shall employ and maintain on the works a suitably trained and experienced supervisor, for the duration of the contract. The CA shall have the right to require replacement of any such person whose general conduct or quality of supervision is in the CA's opinion unsatisfactory.

1.15 Site Cleanliness

It is the responsibility of all operators to maintain site cleanliness. The Contractor shall provide and enforce all site cleaning procedures to the CA's requirements.
Prior to any air system being started all of the following must be signed off', as being complete by the CA:

a) Temporary protection of air inlet if site conditions require.
b) Cleanliness of pipework
c) Cleanliness of ductwork.
d) Cleanliness of electrical switchgear, lighting fittings and accessories
e) Dust sealing of all structural and Architectural components within the air-stream (floor voids and ceiling voids included).

1.16 Access for Plant installation and Subsequent Removal

Before work is put in hand and orders are placed for large plant, the Contractor is to check on site or with the drawings if the plant has to be ordered before the building work is at a suitable point, the dimensions of all doorways, etc., serving as access to ensure that each item can

be admitted to its allotted position and installed in such a way together with all other services, and that it can be replaced with similar replacement equipment at some future date.
The Contractor can be called upon by the CA to demonstrate that plant and equipment can be removed for replacement or maintenance purposes and replaced, using the same materials except gaskets. Should the Contractor find during installation that it is not possible to make any equipment removable, then the Contractor must modify the arrangement in conjunction with the CA and all others concerned. On no account can the CA accept equipment that cannot be readily maintained in position, unless specifically agreed in a particular case in writing when maintenance after removal would be accepted.

1.17 Painting and Galvanising

The Contractor shall be responsible for protecting all equipment that has been installed from damage, and shall thoroughly clean all equipment before it is handed over. Any damaged paintwork shall be made good in colour and type of paint to match the original manufacturers finish. Mild steel or iron brackets or other items to be built-in are to be painted before building-in. In the case of materials or plant which is delivered to site already primed, the Contractor shall ensure the primer is suitable for the type of paint to be subsequently applied and shall make good any damage to the primer before further coats are applied. All items to be painted shall have an undercoating and a finishing coat in addition to the primer appropriate to the material being painted. The finishing coat shall be to a colour to be approved by the Engineer.
All paints including primers, undercoats and finishing coats shall be of the best quality and shall be obtained from a Company approved by the Engineer, and shall be used in accordance with the makers instructions. Painting shall be done in accordance with the best practices in the trade. All surfaces must be thoroughly prepared including removal of dust, grease and protective coatings and in the case of iron or steel, the removal of rust and scale by abrasion followed by the application of an anti-rust solution to remove pitted rust.
Where a galvanized finish has been specified it shall be applied by the hot dip process to BS ENIS01461: Specification for hot dip galvanised coatings on iron and steel articles. Except where otherwise approved, all iron and steel shall be galvanised after sawing, shearing, drilling, punching, polishing and machining are completed. The coating shall be smooth, clean, of uniform thickness and free from defects. Galvanising shall not adversely affect the mechanical properties of the coated material. Any surfaces which have deteriorated or become damaged prior to handover, shall be made good by cleaning and applying a cold galvanising paint.

1.18 Storage (Direct contracts only)

Unless otherwise stated in Particular Requirements, no storage facilities will be provided by the Client for the use of the Contractor. Should the Contractor come to some suitable arrangements with the person in charge of the establishment, for this purpose, the Client will not be responsible for any loss or damage that may be sustained.

1.19 Redundant Materials (refurb/strip outs only)

The Contractor shall allow for the disconnection, removal and carting from site of all materials and equipment made redundant by the new installation. The redundant installation shall be confined to only the existing installation made redundant by the works specified herein and shown on the contract drawings. Other parts of the existing installation shall remain intact and undisturbed. If disturbance cannot be avoided, the installation shall be replaced in a workmanlike manner. The existing installation of lighting etc. shall remain intact until replaced by the new, when it shall be dismantled by the Contractor. Where it is necessary to remove or divert any part of the installation in order to facilitate the carrying out of the new installation, the method of effecting the alterations and the materials to be used must be approved by the Engineer.

The Contractor shall strip out and dispose of all redundant wiring, fittings and materials from the existing installations where applicable to the contract, and shall allow in their tender any monies received in payment for scrap and/or redundant equipment.

The Contractor shall ensure materials are removed from site regularly to avoid inconvenience and danger to occupants. Disposal of hazardous waste shall be carried out in strict accordance with "The Hazardous Waste (England and Wales) Regulations 2005". All waste is to be segregated and disposed of in the most appropriate manner e.g. recycled, reused or as a last resort sent to landfill. Other parts of the existing installation shall remain intact and undisturbed.

1.20 Drawings

All drawings provided by the Contractor shall be produced in electronic format using AutoCAD software.

Drawings submitted for comment shall be in paper format and not larger than A1 size unless previously agreed. Electronic copies of the drawings shall be submitted in both PDF and AutoCAD formats.

1.20.1 Approvals
It shall be the Contractor's responsibility to ensure that drawings are submitted to the CA for comment in sufficient time to avoid delay in the works.

The Contractor shall be responsible for any omission, errors or any discrepancies in the drawings and other particulars supplied by the Contractor or the Contractors suppliers, whether such drawings or particulars have been commented upon by the CA/ Engineer or not, provided that such omission, errors or discrepancies are not due to inaccurate information of particulars furnished in writing to the Contractor by the CA.

Comments on any drawing by the CA/ Engineer shall not mean that the CA/ Engineer is responsible for the correctness of the drawing or its suitability for purpose. These responsibilities shall remain with the Contractor.

1.20.2 Contract drawings (large projects only)
The whole of the work shall be executed according to the true intent and meaning of the contract, specification and drawings, and to the entire satisfaction of the CA. If during the tender period a discrepancy is noted, the Contractor shall inform the CA for the purposes of clarification.

The final position of equipment shall be taken from the installation drawings which have been commented upon by the CA. Diversion of conduits and cables to avoid clerestory windows, roof lights. doorways and other services and slight variations will not be considered for extra payment.

All specifications, drawings and documents remain the property of Engineering Design Practice Ltd.

The position of equipment, accessories and other points may require adjustment to suit the layout and these shall be agreed with the CA.

The Architectural drawings shall also be used to obtain details of tiling, finishes and furniture layout, etc, when planning the position of all other items of the electrical/mechanical installation. The hanging of all doors shall be confirmed before commencing any installation work.

1.20.3 Manufacturers drawings
Shop fabrication drawings shall be developed from, and fully co-ordinated with, the current contract drawings for the Mechanical and Electrical installations, Architectural and Structural Engineering construction drawings.

Drawings shall be fully detailed and dimensioned indicating centres of supports and manufacturing details of the brackets which shall be submitted to the CA for comment. The Contractor shall allow sufficient time within his programme for site dimensions to be taken and not totally reliant upon the contract drawings.

Dimensions given on the drawings are nominal sizes. All dimensions of ductwork shall be internal clear air way as shown on the drawings. Where ductwork is specified as being acoustically lined internally, these shall also be the clear inside dimensions.

Any errors in the manufacture of the ductwork requiring alteration shall be corrected at the Contractor's expense without delay to the agreed construction programme.

Manufacturers plant and equipment fabrication drawings shall be submitted to the CA for comment 14 days before manufacture commences. It shall be the CA's responsibility to ensure that comments are returned without causing delays therein. All drawings shall be produced using the current release of Auto CAD at the time of Installation

1.20.4 Installation drawings
Work shall not commence until installation drawings have been commented upon by the CA. Delays due to late or inadequate submission of drawings or information will not be accepted. Works undertaken without CA's comments having been made will be at the Contractor's own risk.

The following drawings shall be submitted to the CA for comment. This list is not exhaustive and additional drawings may be called for within the design and construction period:

- Mechanical Plant & Electrical Switch room layouts.
- Co-ordinated pipework layout
- Boiler flue installation drawings
- Co-ordinated mechanical & electrical drawings
- Electrical installation including power and control wiring
- Electrical Distribution switchboard/panels
- Builders work in connection
- Under floor heating
- Co-ordinated external services

1.20.5 Revisions and Variations
Where schemes are subject to revision or variation, then the installation/working drawings, and finally the record drawings, must show the full effect. Where the scheme revision involves change to the Architectural or Structural details immediate notice must be given to the CA. Where scheme revisions are required to the works due to the Contractor's variation or revision then all cost for such revision will be the Contractor's responsibility including the design team consultants' costs incurred in the incorporation or administration of such revision.

Designer's drawings must not to be used on site, all actual and proposed installation must be recorded accurately on a site set of drawings updated and available for inspection on site.

Where drawings are revised and updated during construction these shall be issued to the CA for comments on the revision only.

Only if the Contractor can give proof that a significant departure from the intent of the Specification has been necessary will a variation be recorded. This will not include normal detail development relating to inclusion of, nor development of, factors within the Contractor's design responsibility.

The Contractor shall maintain, on site, a detailed marked-up record of the progress of the works detailing the extent of completed installation and all departures from the installation/working drawings. This site record must be incorporated in to the draft record drawings at no more than monthly intervals.

1.20.6 Builders Work Drawings

The Contactor's attention is drawn to the fact that some builder's work provision may have already been made within the design development interfacing with the Architectural and Structural Engineering schemes.

The Contactor shall be responsible to detail their installation/working drawings around the Builder's Work information provided by the CA. If the Contactor considers it necessary to amend any Builder's Work information, the Contractor shall bring this to the attention of the CA who will amend drawings if appropriate.

The Contactor shall prepare all other necessary Builder's Work Drawings required for the execution of this Contract, making due reference to the Structural and Architectural final dimensioned detail drawings as applicable. All drawings must be fully dimensioned.

The Contactor shall be required to mark on site actual locations of all builder's work holes through walls, partitions, floors, etc., and also chases in walls, floors, etc., for conduits, pipes and the like and offer them for inspection by the CA prior to carrying out any work. The Contactor shall establish a method of working with the CA to ensure the works may proceed without hindrance.

All Builder's Work drawings provided by the Contactor must be provided in sufficient time to comply with the agreed programme requirements and all costs arising from failure to do so will be met by the Contactor.

The Contractor shall submit detailed builders work requirements to enable holes through the structure, over an above 50mm dia. to be constructed ahead of the installation and be incorporated into the building construction without causing delay to the building programme.

The drawings submitted to the CA shall include full details of all plant bases. Plant bases shall be of a minimum 150mm clear height using materials commensurate with the floor on which the plant is to be located.

Openings in the roofs shall include an upstand kerb or collar. The Contractor shall provide an over flashing apron over the upstand. The collar shall be fixed and sealed to the side of the ductwork.

1.20.7 Drawing Co-Ordination

The Contractor shall be responsible for ensuring that the drawings are fully co-ordinated with all other disciplines for the purpose of construction comprising Architectural, Structural, Ductwork, Sprinkler, Mechanical & Electrical services drawings.

Any clashes shall be corrected at the Contractor’s expense and without affecting the construction programme. Comments made by the CA or the nominated representative shall not relieve the Contractor of his responsibilities in this respect.

1.21 Contractor’s Submittals

The Contractor shall submit full details of the equipment to be used for the complete installation. It is the Contractor’s responsibility to provide the required information prior to orders being placed. Any changes to the equipment proposed and that installed without written agreement from the CA, shall be changed accordingly at the Contractor’s expense. Submittals shall be in addition and not in place of samples. Submittals shall contain, as a minimum, the following applicable to the specified scope of works. Although the CA or the nominated representative will inspect all submissions, the Contractor shall not be absolved of their contractual responsibilities in respect of the installation and the scope of works. Any comments made by the CA do not constitute approval.

1.21.1 Equipment Technical Submissions

i) Fully detailed technical submission of all selected materials, items of plant and equipment:

- Manufacturer
- Type/Model
- Physical Size
- Output/capacity/duty
- Speed
- Electrical Load
- Sound levels
- Thermal insulation
- Electrical containment

ii) Schedules are to be submitted for the following equipment:

- Boilers
- Heat pumps
- Air handling plant including supply and extract fans
- Heat recovery ventilators
- Heat emitters
- Dampers (fire, volume control etc.)
- Silencers, A/V mounts, inertia bases
- Valves (isolating, regulating, control etc.)
- Grilles and Diffusers
- Under floor heating system
- Natural Ventilation system components
- Automatic controls and BMS
- Lighting fittings
- Automatic lighting controls (presence/absence detection)
- Switchgear and accessories
- Hand dryers
- All specialist equipment

1.21.2 Other submissions required

- Fully priced schedule of rates
- Certificate of compliance with contract information including specification and drawings
- Operating & Maintenance Instruction Manuals (2 copies)
- Building Log Book

1.22 Builders Work

1.22.1 Sub-Contracts

The Contractor shall provide for attending on the site from time to time as and when they are required to set out the works and to instruct the Main Contractor as to the position of holes, bases, supports, etc.

Unless otherwise specified the Main Contractor shall carry out all work for engineering foundations, structural steelwork, cutting away and making good in walls, floors and ceilings, the cutting out and grouting in of clips, brackets, holding-down bolts, cutting of chases, etc, removal and replacement of other parts of the building fabric as may be necessary.

The Contractor will provide 150mm general/earthenware/plastic ducts within the foundations and/or floor slab of the building to facilitate the installation of the cables entering or leaving the building. These ducts shall be at the required depth and far enough from the building perimeter wall to finish in soft earth away from the areas of hardcore, ash, tarmacadam and paving.

Within the building the ducts shall terminate in the required position close to the relevant wall using easy bends (minimum bending radius of 1.2m), to facilitate the careful installation of conduit wiring accessory boxes and fixings generally.

The Contractor must allow for carrying out all their own associated builders work involved with such items as, drilling and plugging the structure for the fixing of any materials or fittings etc., or the supply of any clips, brackets or holding-down bolts, and must allow for the carrying out of this work and the supplying of the materials. This also applies to the supply, installation and painting of support steelwork for fusegear, switchgear, cables, cable tray and wiring enclosure, starters, control gear and lighting fittings etc.

The Contractor shall be responsible for drilling all their required holes up to and including 100mm diameter. The Main Contractor shall be responsible for all holes and openings greater than 100mm diameter.

The Contractor shall prepare drawings showing the positions and dimensions of all holes, ducts, chases etc., to be precast, built or cut in floors, roof, walls, ceilings or at any other position for the installation of the works, also drawings showing the size and construction of plinths, bases, special support of foundations required for this equipment.

These drawings shall be submitted to the Main Contractor with copies to the CA for comment. They shall be complete and show

all the relevant dimensions, in particular the sizes, depths and locations of holes, bolt holes and ducts, etc.
The Contractor shall note that although the cost of incidental builders work is excluded from their contract, the cost of alterations due to inaccurate setting out must be borne by the Contractor. Before manufacturing any item of equipment required to register with holes to be cut by the Builder, the Contractor shall verify that it is in order for the holes to be cut in the position marked.

1.22.2 Direct Contracts

This will be the responsibility of the Contractor.
All cutting away and making good shall be carried out by the Contractor. This shall include making good plastered surfaces and painting conduit and conduit accessories to match existing using competent specialist tradesmen.
Decoration of complete walls and/or rooms and/or wallpapering shall be carried out by others under a separate contract but the Contractor shall be responsible for leaving the works and making good, clean and prepared for following trades.
The Contractor's attention is drawn to the fact that buildings in any condition should be respected as such, and that care should be taken when cutting away. The cost of repairing any unnecessary or excessive cutting away will be charged to the Contractor.
When considered necessary, removal and replacement of fixed and permanent floor coverings, making good and minor reductions shall be carried out at the discretions of the Area Property Manager or persons, to be employed by the Contractor, but selected by the Area property Manager. The cost of these works shall be expended from a Provisional Sum.
When the contract works are being carried out in Listed Buildings, particular care should be taken and advice sought from the CA.
The Contractor shall use rotary masonry drills for fixings and boring holes through walls, floors etc, the use of percussion cutting tools will not be permitted in any part of the building.
When required, timber noggins shall be provided by the Contractor drilled and fixed in the required location to facilitate the installation of conduit wiring accessory boxes, and fixings generally. Fixing direct into false ceiling steel grid systems will only be allowed, using approved patent fixings.
The use of Disc Cutters in occupied buildings shall not be used unless written permission has been given by the Engineer in the interests of preserving the building fabric for a specific reason.
The Contractor shall dig, backfill and reinstate all cable trenches. When applicable, footpath, roadway or area lighting columns shall be placed perfectly vertical with the electricity cut out access door facing the required direction to facilitate easy maintenance and to avoid obstructions.
Dry concrete weak mix shall be poured around the base of the column to a depth of 150mm. A Polythene duct shall be provided from within the column cable chamber to a suitable distance in accordance with manufacturer's requirements from the column and within the ground to enable incoming and looping-in cables to be installed so that 'digging-out' close to the column, can be avoided.
Backfill and compact to within 200mm of ground level thence with 150mm dry concrete weak mix and finally with a 50mm concrete collar to dress the paving. If necessary finish to match other forms of dressing.

1.23 Setting Out and Co-Ordination of Services

The position of items of electrical equipment and plant indicated on the drawings are approximate and shall be used as a guide for tendering purposes. The exact position for fixing shall be determined on site to the approval of the Contract Administrator/ Engineer.
Where possible, items on vertical surfaces at varying heights shown adjacent to each other in the drawings shall be fixed vertically in line. Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines and/or the edges of the equipment. Items fixed within fair faced brick or blockwork, shall have their heights adjusted to centre on horizontal course lines.
The Contractor shall be responsible for marking and setting out on site of all items, which shall be carried out in accordance with the requirements of the contract programme.
In order that the best use may be made of the space available for the disposition of services, it is essential that the Contractor shall co-ordinate their own work with the work of others carrying out installations on the site. The Contractor may be required to prepare such detailed drawing of the proposed position of plant and equipment as may be required to enable the work to be co-ordinated in the general construction of the building, and to attend any meetings which may be called for this purpose.
The Contractor shall be required to co-operate with any other specialist contractors who may be working on or be connected with the contract works. In positions where construction work and other services are to be installed, adjacent to or in the vicinity of these contract works, the Contractor shall co-operate in every respect with all parties concerned.
In positions where other installations and services are complete, the Contractor shall coordinate their installation accordingly so as to avoid disruption to these services.
In the event of other existing services requiring alteration to enable the services to be installed, the Contractor shall obtain written authorisation from the CA for alteration or amendment before such work is carried out.

1.24 Fixings & supports

The Contractor shall supply and erect all steelwork brackets for equipment they are required to erect. Such brackets and supports shall be as manufacturer supplied or purpose made in accordance with the appropriate specification or drawings. All brackets and steelwork unless prefinished, shall be painted or treated before erection or any other equipment is fixed onto them.
All external steelwork fixings shall be galvanised. Fixing to brickwork shall be made direct into the brick or block and not the bond, unless the work is being carried out in an historical or listed building. Methods of fixing shall be appropriate to the weight and type of equipment being installed and shall comprise either screws and plugs, expanding bolts, nut and bolt or chemical fixings. Where there is any doubt as to the type of fixing that should be used, or the material into which the fixing is to be made, then specialist advice and the approval of the Engineer or Contract Administrator shall be sought.
It shall be the responsibility of the Contractor to ensure, that where necessary, all supports, brackets, steelwork, timber noggins etc., are built into the building fabric at the appropriate time during the construction process. No steelwork or laminated timber beams/columns shall be drilled or cut for any purpose without the prior approval of the Engineer or Contract Administrator.
The supply and fixing of all supports, brackets, clamps and spacers and any other steelwork, whether or not shown in detail on the drawings required for the proper and effective fixing of any equipment, shall be considered to be included in the material and labour covered by the supply of that equipment.
Suitable special spanners shall be provided for bolts and nuts which are not properly accessible by an ordinary spanner.

1.25 Clearances

Access clearances to system components shall provide adequate space for the operation, servicing and removing without disruption to or dismantling of other equipment and accessories.

1.26 Concealed Work

Whenever work requiring inspection or testing is subsequently to be concealed, due notice shall be given to the CA so that inspection may be made or tests witnessed before concealment.
Failure to give due notice, of at least 48 hours, shall necessitate the Contractor uncovering the work and reinstating it at the Contractors own expense.
The CA reserves the right to forego their inspection, this will in no way relieve the Contractor's responsibility to comply with the Employer’s Requirements.
Where the CA believes that the installation may be defective the Contractor shall at his own cost uncover a specific area selected by the CA for inspection. This shall be restricted to 1 linear metre or 1m2 depending on the nature of the work for each area of concealment. Reinstatement shall be at the Contractor’s expense. Where works are proven defective by such uncovering, the entire installation shall be uncovered and brought into compliance with the specification.

1.27 Off-Loading and Installation

The supply, delivery, off-loading, positioning and installation of all equipment and materials detailed in the Specification or shown on the tender drawings shall form part of the contract works. This shall include the provision of all necessary craneage, hard standing for same, lifting tackle, trolleys, skids, tools, ladders, temporary workshop, gangways, fences, scaffolding other than that already erected, etc, and shall include the subsequent removal.
The strength of floors across which heavy loads are to be moved shall be checked well in advance of the load being applied so that any routes of inadequate strength can be additionally supported without delaying the progress of the works.
Plant and materials shall not be deposited on roadways, footpaths, corridors or rooms unless prior permission has been obtained in writing.
The Contractor shall be responsible for making good any damage caused in the off-loading, movement or storage of materials and plant.
Any materials or equipment damaged while carrying out these operations shall be replaced at the Contractor’s expense. Where it is necessary to store on site materials and equipment for later installation it shall be properly protected from damage and theft.
In general the material and equipment shall be immediately placed in a clean dry storage area which is enclosed and with the access lockable to prevent removal from site.
If the space is not for the sole use of the Contractor then adequate protection shall be provided to prevent damage resulting for the use of the space by others.
Unless the above provision is fulfilled, certification for payment of a valuation claim for the material and equipment will not be issued.
All materials and equipment which suffers damage while stored, or becomes dirty, dusty or water damaged shall be replaced at the Contractor’s cost.

1.28 Protection of Works

The Contractor shall ensure proper protection of the building, the site, installation and materials from damage due to their own work, building operator/users activities, other Contractor’s operations, vandalism and weather.
Materials which suffer deterioration or rust will not be accepted and the cost of replacement or wire brushing, cleaning and repainting will be borne by the Contractor.
To ensure adequate protection of materials, no material shall be delivered to site until they are required in accordance with the installation programme.

This shall not be considered for delay on progress or completion of the contract.
Second fix materials, e.g; accessories, radiators, light fittings, plant, and equipment face plates shall not be fixed in place until all decorations have been completed.

1.29 Provision of Dust Sheets and Scaffolding

(Existing and occupied buildings) The Contractor shall allow for moving and replacing loose furniture and erecting scaffolding over fixed furniture as necessary for progressing the work.
Each room or area completed by the Contractor for re-occupation by the Client shall be cleaned, and all furniture replaced before occupation takes place.
The Contractor shall provide dust sheets and use them to cover furniture in every area where work is taking place. In addition to these areas, other areas in which builders work dust can drift and settle shall also be protected by dust sheets. Particular attention shall be taken to the protection and cleaning of kitchen areas.

1.30 Inconvenience to Occupants

(Existing and occupied buildings only) The Contractor shall ensure that, when work is being carried out in occupied buildings, any inconvenience caused by the presence of the Contractors workforce is kept to an absolute minimum and on no account should the occupants of such building be harassed or aggravated by operatives creating a disturbance due to shouting, whistling or singing. Under no circumstances shall portable radio or music players with loud speakers be used during working hours, inclusive of lunch and tea breaks.
The Contractor's work force shall conduct themselves in a courteous manner at all times. It will be deemed that the Contractor has made due allowance in his tender for the lack of continuity of works due to the aforesaid inconvenience taken to the protection and cleaning of kitchen areas.

1.31 Maintaining Existing Services

(Existing and occupied buildings only) The Contractor must ensure that all existing services are maintained in good working order at all times during the contract period and all supplies in occupied areas are fully maintained during the required period of occupation.
At no time are staff to be left without the services they require; all negotiations to be carried out via the person in charge of the establishment or persons they so delegate. Where necessary temporary supplies shall be installed, including the use of generator sets where required.
Where alterations to the services involves the disruption to the existing installation which is to remain, the Contractor shall test the installation prior to any works commencing and report any defects/deviations from the standards to the CA. Test and inspection reports shall not be relied upon for this information.

1.32 Safety Precautions

The Contractor will not be allowed to use any naked lights, acetylene cutting or welding plant or to make any fires without a method statement and risk assessment agreed by the CA, and an appropriate permit to work issued.
The Contractor shall be responsible for the condition of all their own/hired plant and portable hand tools used by him for progressing of the works. All portable tools must be 110 volts and fed from a double wound transformer, with the secondary mid point connected to earth.
Should it be necessary to install temporary supplies, this should be done in such a way that the safety of the staff and pupils/building occupants, visitors are given priority consideration, and is in no way hazardous or detrimental to them, or the existing building and building fabric.
The Contractor shall effectively cordon off areas where work is being undertaken. Where floor duct covers are removed, the opening shall be securely barricaded to a standard not less than acceptable for a public walkway. Should the remaining access available be less than 600mm wide then a "no through route" shall be declared. Suitable warning notices stating "Duct covers removed" or "Danger work in progress" for example, shall be displayed at all times. Escape routes must not be impeded, any alternative shall be agreed with the CA.
Access equipment, (i.e.; workstations, scaffolds, steps and ladders), shall be protected and made safe by a tradesmen in attendance at floor level.
All materials and equipment shall be stored and left in a safe position to prevent any hazards to building occupants, visitors or operatives.
The Contractor shall ensure that all their operatives, sub-contractors and tradesmen comply fully, at all times, with the Health and Safety at Work Act and CDM regulations.

1.33 Asbestos (Existing and Occupied Buildings)

The Contractor shall be aware that there may be asbestos based products installed within the existing building(s) and the Contractor shall take suitable steps to ensure that all their staff and sub- contractors are aware that asbestos may be encountered.
Before undertaking any work or disturbing existing materials the Contractor shall check a copy of the Asbestos Register which records where asbestos is probably present. The Asbestos Register is not a definitive record of all asbestos on the site. The Contractor shall consider whether a more detailed survey is required before commencing work. Under no circumstances shall a Contractor disturb any material which may contain asbestos without specific instructions from the CA.
In the event of asbestos being found anywhere on the site works shall stop immediately and must be reported to the CA and the site's Health & Safety representative simultaneously. The CA will take the necessary action outside of this Contract. No works shall be undertaken in these areas until the CA has completed investigations or remedial works and a "Certificate of Clearance" has been given.

1.34 Handover

1.34.1 Testing and commissioning

All testing and commissioning shall be carried out and the results shall be witnessed by the CA prior to practical completion being granted.

1.34.2 O & M instruction manuals and record drawings

Approved manuals and record drawings shall form part of the handover and a certificate of practical completion will not be issued without the final approved documents being handed to the CA.

1.34.3 Padlocks Padlocks or other approved locking devices for equipment supplied under this contract

Shall be provided upon completion of the contract works. All padlocks and other locks shall be provided with two identical operating keys. Each key shall have an engraved durable identification label. It shall be impossible to open any lock or padlock with the key of any other lock or padlock provided under this contract. Keys and locks shall be impressed with the manufacturer's special serial number.

1.34.4 Tools On Completion of the Contract Works

The Contractor shall supply two complete sets of tools (and, when particularly specified, portable indicating instruments) for the safe operation and safe maintenance of all the plant and equipment. He shall also provide suitable means of identifying and storing such tools, complete with a suitable means of securing.

1.34.5 Spares

The Contractor shall at practical completion supply the following spare parts and loose material. In all cases the Contractor shall hand the materials to the person responsible for the building, i.e. Head teacher, Unit Manager, etc, and shall obtain a signed receipt in duplicate listing all items handed over.
Exchange pulleys and belts Include for one spare set of exchange pulleys and belt drives for each belt driven fan and pump installed within the scope of the contract. Belts shall be clearly labelled and hung on a back board in the respective plant room.
Air filters Include for supplying and fitting new air filters to the air handling plant after testing and commissioning is satisfactorily completed and before handover.

1.34.6 Practical Completion

The Contractor shall ensure that the whole of the installation has been tested and commissioned and shall be ready for operation by the date required by the works contract programme.
Practical completion of the Contractor's works or agreed phase of the works will not be given until the Contractor has fulfilled their obligation under the Contract conditions, and in particular demonstrated to the satisfaction of the CA that the following are complete:

- All works are complete other than minor defects which could be reasonably completed within an agreed programme without causing disruption to the use of the building or agreed part. The CA shall be the sole arbiter of what may be considered 'minor', "reasonably completed", "an agreed programme" and "disruption to the occupier".
- All tests and demonstrations have been satisfactorily undertaken in the presence of the CA.
- All final copies of the record/as built drawings, schedules, operating and maintenance manuals and 'Part L' log books have been supplied in a format agreed by the CA.
- All spares, keys, tools, oils, chemicals and other materials required for the running and maintenance of the building services systems have been supplied.
- All instructions and training of the occupier/Employer's staff have been satisfactorily completed.
- All documentation required for the Health and Safety File have been provided as required by the

Practical Completion Certificate shall not be issued until the final and approved O&M Manuals and Record Drawings and documentation has been submitted.
The Contractor shall notify the CA, in writing of the date of completion and handing over of the whole or part of the works so that the date for commencement of the maintenance and defects liability period can be agreed. Failure to do this may involve the Contractor in an extended maintenance and defects liability period. When the whole of the works have been completed, tests have been carried out and the required operating and maintenance instructions and the manuals and record drawings have been handed over to the CA, then the maintenance period shall begin. The CA will confirm the receipt of documentation who will then issue a Certificate of Practical Completion at the time the building is handed over.

1.34.7 Tuition and Training

The Contractor shall provide tuition and training for those representing the building user and/or Employer and the Maintenance Contractor. Tuition and training shall be carried out at practical completion and repeated, by agreement no more than four months after practical completion. When the tuition and training programmes are completed and demonstrated satisfactorily to the Client/end user, the appropriate form included in the project specification appendices shall be signed accordingly.
Training shall be carried out in two parts as detailed below:-

1.34.8 User Training

This is for the building user/occupier, and shall be carried out at once at Handover and once during the defects liability period

as a refresher.
The Contractor shall provide trained and experienced personnel to fully instruct the Building Manager and/or their representative, in all aspects of the operation & control instructions for the building services installation, its plant, equipment & systems.
Any instructions for equipment, plant & controls are to be provided in a simplified format, and encapsulated with a duplicate copy fixed adjacent to respective control panels.

1.34.9 Maintenance Contractors Staff Training

Allowance shall be made to provide trained and experienced personnel to fully instruct the Maintenance Contractor in the operation of all the building services installation, its plant, equipment & systems installed or modified as part of the contract.

This shall be carried out at the end of the maintenance & defects liability period, & before the Certificate of Making Good Defects is issued and as detailed below:-

The contractor shall:

1. include for a minimum of five days (unless specified otherwise in the contract preliminaries or Particular specification) for plant operation and to instruct the maintenance staff, as described above, in the day to day running and maintenance of the plant, systems and equipment. This shall include demonstrating and comprehensively explaining the function of all plant, systems and equipment listed and detailed in Record Documents to the Employer's satisfaction.

2. arrange for, and include the costs associated with, attendance of manufacturers or suppliers representatives as necessary.

3. allow for the fact that the period of instruction may not necessarily take place immediately upon Practical Completion but when considered desirable by the Employer.

4. allow for a further two day period of instruction during either the Summer or Winter whichever is not covered by the initial period.

5. ensure that each manufacturer or supplier of motive plant or equipment or controls includes all costs associated with instructing and training of Employer's staff.

6. allow for the automatic controls and BMS specialist to give detailed instructions and training to the building user and CA during the commissioning stage. This shall be repeated within the first month after handover, 6 months into the defects period and also at the end of the defects period.

The Contractor shall obtain a signature from the CA, and the Maintenance Contractor (when applicable) to signify that operating instructions have been given & understood. This is to be included within the operation and maintenance manual.

1.34.10 Rectification Liability Period

All Installation, materials, equipment and manufacturers warranties are to commence from issue of the Certificate of Practical Completion. The Contractor shall make good at their own expense any defects in workmanship, materials and equipment, fair wear and tear expected. The Contractor shall bear any expense by the Employer as a direct result of defects. The Rectification Liability Period for the Services Installation shall be 12 months unless stated otherwise in the contract preliminaries. This rectification liability period will remain fixed regardless of the maintenance period associated with other contracts or main contracts for the works as a whole. The Contractor shall advise the CA when all outstanding items and defects have been completed or rectified in order that a final inspection may be carried out.
At the end of the Rectification Liability Period under the conditions of the contract, the CA will confirm to the Contractor that there are no outstanding defects. The CA will then issue a Certificate of Making Good Defects.

~~1.34.11 Maintenance, Servicing & Certification (within the Warranty/Rectification Period)~~

~~The Contractor shall include within their tender submission, a full 12 month on site maintenance and servicing of the equipment and plant installed within the scope of the contract works.~~
~~The schedule shall be completed by the Contractor showing the number of visits and respective dates during the warranty period.~~
~~The servicing and maintenance shall be in accordance with the manufacturers requirements and shall also include the following:~~

~~PLANT~~	~~FREQUENCY~~
~~Boilers~~	~~6 monthly~~
~~Air plant filter change and fan pulley adjustment~~	~~Quarterly~~
~~Pumps & fans~~	~~1 per year~~
~~Pressurisation and booster sets~~	~~1 per year~~
~~Mixing valves~~	~~6 monthly~~
~~Chillers~~	~~1 per year~~
~~Gas safety inspection~~	~~On or up to 7 days prior to the date of the 1st~~

~~Costs shall be inclusive of the following:~~

- ~~full training costs for personnel to take over the plant at the end of the 12 month period,~~
- ~~full record of operating and maintenance procedures undertaken for all the plant items installed,~~
- ~~the cost of replacement parts as scheduled for the planned maintenance programmes including the provision of clean air handling filters at handover and cleaning or replacing the filters appropriately during the 12 month warranty.~~
- ~~water treatment chemicals required for normal operation during this period and records of all maintenance carried out by the Contractor shall be handed to the building's responsible person for inserting into and recording in the Building Log Book.~~
- ~~testing refrigerant systems according their charge volumes and issuing compliance certificates tothe Building Manager for inclusion in the Log Book.~~

~~It shall be the Contractor's responsibility to maintain the electrical services until the end of the rectification liability period and completion certificate is issued.~~
~~Where extended warranties of plant are required from manufacturers and/or suppliers, these shall be declared within this separate price. The Contractor is advised to ensure that all risks are covered so that all operating and maintenance carried out during the 12 month warranty period does not invalidate manufacturers warranties.~~
~~When an agreed contract includes the first 12 months maintenance, the Contractor shall submit a programme to the CA for carrying out these works for agreement prior to Practical completion.~~

1.35 O & M Instruction Manuals and Record Drawings (General Requirements)

1.35.1 Introduction

14 days prior to practical completion the Contractor shall submit to the Building Services Engineer a draft copy of the proposed Operating and Maintenance Instructions of the Building services installed for comments. It shall include all the information necessary to provide for the safe and efficient operation and maintenance of the engineering services which comprise these works.
The manual shall meet the requirements of the following: BSRIA BG 1/2007 and follow the guidance and proformas set out in Part 2. It shall meet the requirements of BS 4844: Specification for Presentation of Essential Information; and BS 4940: Technical Information on Construction Products and Services: Guide to Content and Arrangement.
Manuals shall be either Class B or Class D as described in BSRIA BG 1/2007. The appropriate type of manual shall be specified in the Particular Specification or on the drawings. Where not so specified the manual shall be Class B.

1.35.2 Class B manuals

Class B manuals shall generally comprise:
• Record drawings and drawing symbols.
• Manufacturer's operating and maintenance instructions.
• Test and commissioning certificates.
• Warranties.

• Equipment inventories with manufacturers names and addresses.

1.35.3 Class D manuals

Class D manuals shall comprise the contents detailed in BSRIA BG 1/2007, which shall generally be as follows:

• How to use the manual
• Emergency information
• Contractual and legal information
• Systems description and design intent
• Asset list/equipment schedule
• Parts identification and recommended spares
• Spares policy
• Commissioning data
• Operation
• Maintenance recommendations and records to date
• Fault finding
• Lubrication
• Modification information
• Disposal instructions
• Names and addresses of manufacturers
• Index of plans and drawings
• Manufacturer's literature

A Class D manual shall be prepared by a specialist author as recommended by BSRIA or as approved by the Contract Administrator.

Both classes of O & M manual shall include full details of start up and shut down procedures, any necessary schematic drawings showing the location of control valves and plant etc., including where appropriate coloured drawing to indicate areas of zoning. Also included shall be copies of valve charts.

On receipt of the above information the Building Services Engineer shall formally comment within two weeks. The Contractor shall incorporate all such comments and issue a further updated copy to the Building Services Engineer for final comment within one week of receipt of documents.

The Contractor shall handover to the Employer's representative four hard copies and one CD of Operating and Maintenance Instructions NO LATER than the date of practical completion.

Practical Completion may be withheld until the O & M manual has been substantially provided.

Operating and Maintenance Instructions shall be indexed and contained in ring binders with stiff covers. The name of the Site shall be printed on the front and spine with, where more than one volume is necessary, a suitable identification title.

The date of completion of the Works shall be included on a flyleaf. The Instructions shall be fully cross-referenced and co-ordinated with the Record Drawings.

If the documentation is not completed to the full satisfaction of the Engineer the Employer shall be entitled to have the manuals prepared by another firm or company and recover the full costs incurred from the Contractor. No claim for payment will be entertained for manuals partially completed.

~~1.35.4 Building Logbook/ Instructions for Use of the Dwelling~~

~~In order to satisfy the requirements of The Building Regulations Approved Document Part L2 Section 3~~

~~The Contractor shall be fully responsible for the preparation, production and submission of all information required to fulfil the contract requirements for the production of a Building Log Book.~~

~~The Contractor shall be responsible for obtaining and coordinating the relevant information in conjunction with the Engineer and Contract Administrator.~~

~~Failure to produce the required format for the Log Book at the appropriate time may result in Building Regulations approval not being granted. It is therefore imperative that due allowance is made within the tender for this element of work. The information to be provided by the Contractor shall be in accordance with the guidelines set down in the by CIBSE Technical Memorandum TM31.~~

~~The Building Log Book is a single copy of a separately produced document and should not be confused with the any other document.~~

~~The CIBSE approved format (TM31), The Building Log Book Toolkit should be used as the basis to present the required information.~~

~~As a minimum, the format of the Building Log Book will be as follows:~~

~~• Proforma sheet for Log Book Updates & Annual Reviews~~
~~• Introduction, Purpose & Key Responsibilities~~
~~• Links to other Key Documents~~

- ~~Statement of Calculation Results and Assessment for Carbon Emissions~~
- ~~Conceptual Design Overview~~
- ~~Key Operational & Energy Saving Do's & Don'ts Schedule to Optimise the Design Philosophy~~
- ~~Energy Metering, Monitoring, Targeting Strategy (using TM39). Including Metering Schedule & Schematic.~~
- ~~Summary of overall fossil fuel consumption & CO2 against simple benchmarks.~~

~~Due to its nature, much of the required information will be required to be produced by the SBEM Assessor/SAP Assessor and implemented as part of the scheme. The Contractor shall be required to collate all relevant information. Information submitted by the Contractor shall be submitted in draft format 5 weeks prior to practical completion to provide the Contract Administrator sufficient time to review and return comments. The final information shall be produced 2 weeks prior to Handover to enable sufficient time for the collation/production of the completed Building Log Book.~~

~~New Buildings:~~

~~The building logbook should provide enough detail of installed plant, controls, method of operation, maintenance which will allow energy consumptions to be monitored and managed effectively.~~
~~The information should be provided in a summary form suitable for day to day use. The logbook is intended to enable the building occupier to operate the building in an energy- efficient manner in accordance with the design intent. It should include:~~

1. ~~Description of the building and design philosophy~~
2. ~~Location of plant . instructions and simplified schematic diagrams~~
3. ~~Target emission rate (TER) and building emission rate (BER) calculations~~
4. ~~Location, description and instructions for any energy meters~~

~~Existing Buildings:~~
~~A new or updated building log book should inform:~~

5. ~~Location of new plant, instructions and simplified schematic diagrams~~
6. ~~Location, description and instructions for any new energy meters~~
7. ~~Any other details that collectively enable the energy consumption of the building and building services covering the works to be monitored and controlled.~~

~~The Mechanical Sub-Contractor shall provide information about the building in accordance with the requirements of Part L1A and L1B of the Building Regulations. This should provide the occupier of the dwelling with sufficient information about the building and the fixed building services to allow them to operate the dwelling using no more fuel or power than is reasonable in the circumstances.~~

~~This can be done by provided a suitable set of instructions aimed at achieving economy in the use of fuel in terms that the householder can understand in a durable format that can be kept for the life of the equipment.~~

SECTION TWO

MECHANICAL STANDARD SPECIFICATION

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2. MATERIALS AND WORKMANSHIP – MECHANICAL SERVICES

2.1 Heating Systems

Heating systems shall comprise all necessary pipework, isolating and balancing valves, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings, Specification and Appendices and tender drawings. Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.2 Pressure vessels

On completion of the installation the Contractor shall provide to the Employer's insurance company all information on the system expansion vessel as is required under Statutory Instrument No.2169 'The Pressure Systems and Transportable Gas Containers Regulations 1989'. The Contractor shall obtain from the insurance company a certificate for the installation and this shall be included in the O & M Manual. A written scheme for working on the vessel(s) shall also be included in the O & M Manual.

2.3 Boilers

Boiler(s) must be installed strictly in accordance with the manufacturers instructions and shall be commissioned and set to work by the manufacturer's engineer or appointed agent.
The commissioning certificates shall be included in the O & M manual and laminated and fixed securely in the respective boiler room. All joints shall be rendered air-tight, to prevent air from entering and gases from leaking from the combustion chamber, flue-ways and smoke connections.
Doors and plates covering orifices into the combustion chamber are to close tightly, and shall be free from warping. Where sectional boilers are constructed on site they shall be flushed out with clean water after assembly before pipe connections are made. All floor standing boilers shall be mounted on builder's work bases. Boilers shall be suitable for the fuel and firing method detailed elsewhere. Cast iron boilers are to comply with BS 799 where applicable. Welded steel boilers are to comply with BS 855 where applicable. Boilers shall be provided with makers standard casings, insulation, controls and instrumentation, and shall be suitable for the working pressure of the system. Where gas fired boilers are installed, whether fitted with forced draught or natural draught burners, a gas leak detector system is to be fitted in the boiler house, as detailed elsewhere. All condensing boilers shall include a condense connection. Condense shall be carried away from the boiler to the buildings drainage system via suitable plastic pipe. Under no circumstances shall copper or steel pipe be used.

2.3.1 Controls

The boiler(s) shall be manufactured with an integral, adjustable water temperature control thermostat suitably ranged for the operating temperature of the system to be served. The adjustment may be effected by manual or automatic means as detailed elsewhere. The boiler(s) shall be manufactured with an integral water temperature over heat high limit cut out thermostat with manual resetting. Gas fired boilers shall be supplied with an integral gas control valve incorporating all safety devices.

2.3.2 Instruments

All boilers shall be fitted with a thermometer, an altitude or pressure gauge, a safety valve and drain cocks, in accordance with the following details. Where not an integral part of the boiler, thermometers and altitude/pressure gauges shall be of a similar make and style. Thermometers are either to be integral part of the boiler instrumentation provided as standard by the boiler manufacturer, or one of the following types: a) To BS EN 1319 : mercury in steel type, dial thermometers of 1mm diameter, vertical or coaxial. They shall have black steel cases with chromium plated bezels, and the dials and indicating hands shall be protected by a plain glass front. The dials shall be calibrated from 10°C to 120°C. b) Where indicated in the Particular Specification small dial thermometers of 65mm diameter approximately shall be fitted to the boiler. They shall be of the bimetal coaxial type, calibrated from 10°C to 120°C, having either a red and white moving indicator disc or a black pointer, and a fixed temperature scale, with a plain glass front.
Dial type thermometers shall be provided with tails screwed 15mm BSP male. A separate steel well, threaded 25mm BSP male by 15mm BSP female is to be fitted into the pocket and filled with heat-conducting grease before the insertion of the thermometer.
Where thermometers are installed in pipelines and the diameter of the pipe is too small for the length of the standard bulb, the pipe shall be increased to the requisite diameter for the length of 15mm to allow for the proper fitting and insertion of the thermometer well. Thermometers should be fitted on the flow mains close to the boilers and in positions where they can be read easily.
Altitude and pressure gauges to BS 178 with 1mm diameter dial, having a brass case, with 1mm BSP bottom connection. Gauges shall be calibrated in metres head and bars pressure, the maximum scale range being no one and a half times the working pressure of the system. Gauges of excessive scale range will be rejected. The indicating hand is to be black and an additional red hand is to be fitted which shall be set to the standing head of the system. A plain glass front is to be fitted to the gauge to protect the dial and indicators.
A lever handle isolating cock is to be fitted between the gauge and the boiler/pipe. Gauges are normally to be fitted to a tapping at the front of the boilers, but where manufacturers do not provide for this, gauges shall be fitted on the flow main close to the boilers and in positions where they can be read easily.

2.3.3 Connections

Boiler connections shall included flow, return, open vent (as necessary), cold feed, drain off and safety valve of the size and type shown in the boiler schedule and indicated on the drawings.
Spring loaded safety valves of appropriate size for the boiler rating and correctly loaded for the maximum working pressure shall be fitted. All safety valves shall have a copper or galvanised steel overflow pipe carried clear of the boiler insulation and turned over to discharge downwards.
Safety valves shall be padlocked and keys shall be handed over to the person responsible for building or the Main contractor whichever is appropriate to the type of contract.
Emptying cocks shall be fitted to each boiler, to enable all the water to be drained. Where it is not possible to fit the mountings directly on to the boiler, they may be fitted to the flow or return pipework connections, as appropriate, as close to the boiler as possible, before any valves.
Where two or more boilers are connected together on open vented systems, a safety vent pipe connection of the size shown on the drawing shall be run from each boiler and connected to a common boiler safety vent pipe, via a three-way safety vent cock, arranged so that the boiler vent connection is always open to atmosphere. A relief pipe is to be run from the third connection of the vent cock, carried clear of the boiler and turned down to discharge to within 45mm of floor.

2.3.4 Locating

Floor mounted boilers shall be situated on a solid plinth of dimensions as indicated on the drawings. Plinth to be of a strong, smooth non combustible construction with a level finish.
Wall mounted boilers shall be supplied with all brackets and fixtures as detailed in the manufacturers instructions.

2.3.5 Maintenance

The boilers shall be located to give all round clearances for maintenance and dismantling strictly in accordance with the drawings and manufacturers minimum requirements and instructions.

2.3.6 Cleaning tools

Cleaning tools and brushes shall be supplied with each boiler mounted on a board in the boiler room.

2.3.7 Documentation and certification

All boilers shall be supplied with a full set of the following documentation: (i) Installation instructions. (ii) Maintenance instructions which is to include a spare parts schedule. (iii) Users instructions. Boilers shall be provided with test certificates, model numbers and data badges. Sectional boilers fabricated on site by the manufacturer shall be pressure tested to twice the system working pressure and then heat tested during commissioning. After satisfactory testing a certificate must be issued by the manufacturer which is to be included in the O & M manual.

2.4 Burners

Burners shall be provided as either an integral part of the boiler assembly or be a manufacturers matched component to the details as given in the Particular Specification and Equipment Schedules.

2.4.1 Pressure jet oil burners

Oil burners shall be of the fully automatic pressure jet pattern, incorporating fuel pump, fan, start and purge timing device, EHT electrical ignition and photo electric flame failure shut off device. Oil burners shall be manufactured and installed in accordance with the current edition of BS 799:Part 3, current edition.
Oil burners shall be fitted with a flexible oil connection run from the oil feed line and the feed line is to terminate with a gate valve and oil filter. The filter is to be suitable for the grade of oil in use and shall have a transparent bowl of unbreakable material. Where the oil feed system is of the independently pumped circulatory type, an oil pressure reducing valve is to be fitted immediately after the isolating valve. The reducing valve is to be set to give an outlet oil pressure consistent with the requirements of the oil burners.
The Contractor shall include for a return visit to site after the plant has been in operation for one month to undertake final test readings and adjustment of burners, including any change of nozzles. A written report shall be forwarded to the Contract Administrator (CA), quoting for each boiler:-

1. Flue gas outlet temperature
2. CO_2 reading.
3. Smoke number.
4. Combustion efficiency.

2.4.2 Forced Draught Gas Burners

Gas burners shall be of the fully automatic forced draught type, incorporating fan, start and purge timing device, EHT electrical ignition and photo-electric flame failure shut off device (for the remainder of gas equipment refer to the relevant section). Gas burner installations are to comply with current legislation and IGEM publications.

2.5 Ground Source Heat Pump Heating Systems

2.5.1 The Fluorinated Greenhouse Gases Regulations 2008

Unless stated otherwise in the Particular Specification, it shall be deemed that ground source heat pump systems included within the scope of works, will contain more than 3kg of man made fluorinated refrigerant gas and the Contractor shall comply with these regulations.
The Contractor shall be responsible for carrying out leakage tests and keeping a record of these tests using the sample record sheet contained within the Appendices in accordance with these regulations during the 12 months defects liability period.

2.6 Open Vented Heating Systems

Open vented system shall only be used when detailed in the Particular specification, otherwise all heating systems shall be sealed. Open vented systems shall include the following:

2.6.1 Vents

Where two or more boilers are connected together, a safety vent pipe connection of the size shown on the drawing shall be run from each boiler and connected to a common boiler safety vent pipe, via a three-way safety vent cock, arranged so that the boiler vent connection is always open to atmosphere.
The relief pipe is to be run from the third connection of the vent cock, carried clear of the boiler and turned down to discharge to within 15mm of floor.
The three-way vent cock is to be of a type specifically designed for this purpose, the purpose of each connection being stamped on the connection nut. The three-way cock to be either a gland cock, or a screw down escape valve.
Each three-way gland type vent cock is to be of gunmetal preventing the isolated boiler being closed to atmosphere. It is to be fitted with an operating key, the square end of the plug being stamped to indicate the position of the ports.
Each screw-down, three-way vent cock is to be of gunmetal, having renewable discs, the handwheel being labelled to indicate the valve condition.
Each main safety vent pipe is to be carried up above the level of the feed cistern which feeds the same boiler or boilers and is to be turned over to discharge into that cistern. Each vent pipe is to be of galvanised tube and fittings from a point 1m below normal water level. Each vent pipe is to be run to rise for its entire length and is to be free from air traps.
Where pumps are fitted in boiler return, the boiler vent is to be extended sufficiently above the feed cistern to avoid priming.

2.7 Feed and Expansion Tanks

The cold feed connection is to be made into the side of the cistern, close to the bottom edge, but made so that any foreign matter entering the cistern shall be trapped in the bottom of the cistern, and not carried over into the cold feed.
The drain connection is to be made in the bottom of the cistern, the cistern being graded to allow all water to be emptied from it for maintenance purposes.
The ball valve connection is to be fitted as close to the top of the cistern as possible. The bottom of the ball valve connection is to be positioned above the level of the top of the overflow pipe, by a distance equal or greater than the diameter of the overflow pipe.
The overflow pipe is to be run with a constant fall to discharge outside the building in a conspicuous position where the discharge of any water from it can be readily seen.
The feed and expansion cistern is to have a removable loose cover complete with lifting handles and slotted to receive vent pipe.
Supports for the cistern shall be covered with bituminous damp course felt of at least the same width as the supports.
No pieces of metal, swarf, filings or other foreign matter shall be left in the cistern when it is installed and the Contractor is to ensure that it is clear of such items before the installation is commissioned and handed over.
The cistern is to be fitted with a ball valve complying with BS 1212 of the same size as the mains water service feeding the cistern. The ball valve shall be either of the drop arm pattern or having a long brass arm, and shall be fitted with a copper ball float to BS 1968 or alternatively a plastic ball float to grade H (red) as described in BS 2456. On no account may plastic ball valve floats to grade C (blue) be used in the feed and expansion cisterns.
The ball valve is to be adjusted so that when the system is filled with cold water there is just enough water to float the ball valve float. A stopcock is to be fitted to the mains water service connection immediately before the ball valve.
A gate valve is to be fitted in the cold feed connection close to the cistern.

2.8 Sealed Heating Systems

2.8.1 Pumped Pressurisation Unit

The filling pump set shall comprise a break tank including a ball valve and overflow pipe, a pump to fill the heating system from the break tank and air cushion, a pressure reducing valve to be set to 1% above the cold fill pressure of the system, a system expansion vessel and a contactor/starter, all being mounted on a suitable baseplate or brackets.
The filling pump set is to be controlled by a pressure sensing switch set to the cold fill pressure of the system. This switch is to be mounted on the filling pump set or in the cold feed pipe from the set to the boiler but no valve shall be installed between the

pressure reducing valve of the filling set and the pressure sensing switch.
A non-return valve is to be fitted in the pump suction pipe from the break tank and a 5mm diameter pressure gauge is to be fitted in the outlet pipe from the reducing valve. Provide and install in the main flow pipe close to the boiler, two pressure sensing switches for high and low pressure limiting purposes. These high and low limit pressure sensing switches shall be wired to shut down the boilers if pressures rise or fall beyond the limits stated in the Schedule.
The standing head of the system, the cold fill pressure and the maximum working pressure shall be as stated in the Schedule.
The pump motor is to be a wound for a 24v/1ph/5Hz electrical supply and the filling pump set is to be internally pre-wired.
On completion of the installation the Contractor shall provide to the Employer's insurance company all information on the system expansion vessel as is required under Statutory Instrument No.2169 'The Pressure Systems and Transportable Gas Containers Regulations 1989'. The Contractor shall obtain from the insurance company a certificate for the installation and this shall be included in the O & M Manual. A written scheme for working on the vessel(s) shall also be provided in the O & M Manual.

2.8.2 Pump-Free Pressurisation Unit

A proprietary WRAS approved pump-free fill set shall be used as detailed elsewhere. The unit shall be complete with high and low pressure controls suitable for relaying to the BMS and/or local control panel. Other control requirements shall be as given in the Automatic Controls Section.

2.8.3 Expansion Vessels for Sealed Systems

Where boilers are installed in sealed and pressurised systems, no open vents are required. An air separator, incorporating automatic air vent, of the size, type and make given in the Particular Specification, is to be fitted in the main flow connection from each boiler of sealed pressurised systems. Closed expansion vessels to BS 4814 of the size, type and make given in the Particular Specification shall be connected to all sealed or pressurised systems.

2.8.4 Metering

The cold feed to the heating system shall be fitted with a secondary water meter.. The meter shall be pulse type and linked to the Auto/BMS controls for remote monitoring.

2.9 Circulating pumps

Provide and install in the positions shown on the drawings, accelerator pumps for heating and HWS primary circulations. They shall be of the number, duty, make and type given in the Schedule Pumps shall be arranged to operate in duty and standby mode.
Each pump shall be capable of performing the duty given in the Schedule and shall be fitted with a nameplate giving the following details:

1. Maker's name.
2. Volume flow rate (litre/s).
3. Developed pressure (millibars).
4. Pump speed (rev/s).
5. Maker's reference.

Each pump motor shall be fitted with a nameplate giving the following minimum particulars: 1. Maker's name. 2. Model reference number. 3. Details of electric supply. 4. Motor speed (rev/s).
Centrifugal type pumps shall be belt driven or directly coupled to the driving motors. Directly coupled pumps shall be mounted on a common bed plate. A sensitive non-return valve shall be fitted in the main between the pump suction and delivery branches and isolation valves shall be fitted to latter.
All pumps with indirect drive shall be fitted with galvanised sheet steel or wire mesh guard over the pump drive.
Motors shall be resiliently mounted on all indirect drive pumps to ensure freedom from vibration in the pipework and quiet operation.
Lubricated bearings on pumps or motors shall be of sleeve or bush pattern with adequate oil reservoirs.
All electric motors shall be of the totally enclosed type, wound for the electric supply available, maximum speed 24 rev/s manufactured strictly in accordance with the appropriate BS Specification for continuous operation in the ambient temperature conditions prevailing. They must be fully capable of driving the pump at the required duty with reasonable margin against overload.
All floor mounted pumps shall be properly levelled on suitable foundation, bolts being provided for grouting in by builder, to details supplied by Contractor if the type of pump used has a bed plate.
In line pumps intended for connecting directly into the pipework shall not cause undue deflection of the pipe and the supports of the latter must be arranged with due regard to the weight of pump unit. Pumps of this type shall either have combined packless glands and seals or be of the immersed rotor type.
Pumps which embody an automatic non-return valve in by-pass shall have isolation valves on the suction and delivery branches arranged so that the pump itself can be isolated and removed without the necessity of emptying the system. Pumps of this type which have repackable glands shall be so designed that the water pressure can be shut off from the stuffing box to permit repacking when required without necessitating emptying of the system.
The Contractor shall supply and fix within the boiler room adjacent to the pumps, blanking plates suitable to allow the out of use

pump head of twin headed pump sets to be removed for maintenance. One blanking plate per pump set shall be provided whether or not there are duplicates.
Tappings shall be provided at the inlet and outlet connections of pumps in heating systems outside the pump isolating valves. Connections shall be run from these to two matched altitude gauges. The gauges shall be as previously described and shall be fitted with lever operated gauge cocks. Heating and HWS primary pumps are to have cast iron bodies.
Isolator/changeover switches and starters shall be suitable both for the available electrical supply and for the motors to which they shall be connected.
Starters for pump motors must not incorporate a no-volt release device, as pumps are required to run immediately the supply is resumed after an electrical shut off. Starters for three phase motors are to incorporate a single phase prevention cut out. The electrical control gear for the pumps is to be incorporated in a control panel. Pumps shall be installed in accordance with the manufacturers recommendations. Any ambiguity shall be brought to the CA's attention.

2.10 Under Floor Heating

The complete system is to be designed by the specialist supplier. Wet under floor heating systems shall cover the required areas to meet the peak heating demand and in accordance with BS EN 1264: Floor heating systems and components, DIN 4725: Hot water floor heating systems; design and Construction DIN 4725-200: Floor heating, systems and components - Determination of the thermal output, pipe coverings larger than 0·065.
The system shall be complete with all floor insulation, floor screed, manifolds, pipework, floor coils, water temperature control, room thermostats and ancillary equipment.
Pipework from the heating manifolds and including the embedded heating coils shall be Polybutylene (PB) Barrier Pipe comprising PB outer tube, oxygen barrier layer and PB inner tube having a 50 year guarantee, be fully recyclable and conform to the environmental policy submitted. Refer also to Section Pipework, Valves and Accessories. Contractor's are at liberty to offer alternatives providing the following performances are met in full:
Pipework Features & Performance:

- Standard & barrier pipes available
- High flexibility even at very low temperatures
- Resistant to stress
- Non-corrosive
- Minimal internal resistance
- Safe installation procedures, no requirement for pre-tempering pipe
- Pipes can be fusion welded – for accessible distribution systems only
- No flame, specialist tools or chemicals required during installation
- Resistant to frost damage
- Proven on installations for more than 30 years and 50 year warranty
- Inert to water hardness/softness
- Unaffected by chemical inhibitors
- Readily recyclable
- Pipework does not encourage micro biological growth
- Does not produce toxic or corrosive gases when burnt
- High impact strength
- Creep resistant Suitable for heating and cooling applications
- Low energy consumption in manufacture
- Multitude of coil lengths for economical installation with minimal waste
- Produced in compliance with ISO 14001
- Sizes and type of coil specifically engineered for embedded coil technology
- Low environmental impact in terms of soil, water and air pollution
- UK manufacture, reducing transport costs and pollution

~~2.10.1 Floating and Screeded Flooring Systems~~

~~Floating floor systems shall include the necessary insulation, heat spreader plates and pipe fixings.~~
~~Floor screeding systems shall include mesh or clips/rails to hold down the pipe. Insulation shall be supplied by the Main Contractor.~~
~~Alternatively a plate system may be employed with integral bonded insulation. The method used to hold the pipes to the insulation shall not compromise the effectiveness of the insulation or the vapour/damp proof membranes. Prior to and during the laying of the floor or pouring of the screed the floor coils shall be filled with water and subjected to a hydraulic pressure of twice the final system pressure.~~
~~Structural expansion or movement joints within floor construction shall not be bridged. Screeds shall align with movement joints having a flexible vertical membrane to ensure their continuity. Flexible 10mm thick membranes shall surround each defined poured/floated screed area to ensure that any differential expansion between screeds and walls and other adjoining screeded areas are allowed to move without cracking.~~
~~Where a secondary floor is to be installed onto a solid screeded floor in which heating coils are buried, the voids shall be~~

~~protected to ensure the floor void does exceed 35°C and the adhesive used for the finished floor covering does not exceed 27°C. High limit control air sensors shall be located on the floor void for each manifold serving the area to shut down the heating if the set point is reached. A ELV controller with transformer shall be located adjacent to the respective manifold and upon high limit being reached shall override the room thermostat and shut the heating down to the circuits served. the controller shall indicate high limit reached which shall be available for extending to the BMS when detailed elsewhere. When the void temperature falls below the high limit set point, the controls shall automatically reset to normal room temperature control. Controllers shall be clearly identified and the high limit setting mounted along side the controller stating: "High limit setting __°C must not be increased" Sensors shall be replaceable without dismantling the secondary floor.~~

2.10.2 Pipework Requirements

The Contractor shall ensure that the pipework is laid in strict accordance with the layout provided by the under floor heating specialist. Pipework should not be laid within 100 mm of the perimeter of the space to allow for the later fixing of any carpet edging strips.
Pipework must not bridge structural expansion or movement joints within floor construction. The heating zone coils and pipework routes from manifolds to heating coils shall be designed accordingly. Straight lengths of pipework passing through walls within the screed, and thereby crossing the flexible membrane between the screed and wall, shall be sleeved for 1.00m in length.

2.10.3 Coils

The under floor heating coils must not exceed 20 mm o.d. and shall be designed specifically to meet the outputs as given in the Particular specification, Equipment Schedules and shown on the tender drawings. The length of the coils will be determined by the room size and the outputs, and no jointing will occur in the running length. The heating coils shall be 20mm o.d. PB Barrier pipework and spaced at 200-300 centres throughout, and installed in a 'reverse return' pattern. The coils shall be fixed to the insulation panel in an approved manner which secures the pipework to prevent lifting within the screeding process. The pipework will terminate at the appropriate wall- mounted manifold locations. Coil flow and return pipework passing through one zone to reach the controlled zone for which it is designed to heat must be insulated with a flexible proprietary pipework insulation system (9-12mm wall thickness) to prevent heat loss en-route to it's destination.

2.10.4 Manifolds

The manifolds shall be provided complete with isolating and regulating valves, temperature and pressure gauges, air vents, drain cocks, wall brackets with rubber isolating inserts and flow indicators. The Contractor shall support the manifolds on a proprietary galvanised steel support frame.

2.10.5 Controls

The under floor heating actuators shall be supplied and installed by the under floor heating specialist, and the controls wiring shall be provided by the control specialist. Room thermostats and all other controls equipment shall be supplied by the control specialist for connection to the manifold circuit actuators. Including high limit sensors and controls as described in the preceding clause B1.10.3: Sprung floor systems. The control strategy will allow for each individual room to be controlled separately, by way of manifold circuit actuators and room thermostats. A laminated schedule shall be securely fixed alongside each manifold clearly showing the user which circuit control valve serves which room and/or thermostat. Wireless room thermostats shall be provided when detailed elsewhere. When wireless thermostats are installed, a laminated schedule shall be securely fixed alongside each receiver clearly showing the user which circuit serves which room and/or thermostat.

2.10.6 Joints

Joints in the slab or screed or in any part of the floor coils will not be permitted under any circumstances and if damage occurs to any part of a loop the whole loop shall be replaced. The under floor heating circuits must be installed in one continuous length without any joints.

2.10.7 Insulation

The under floor heating contractor shall ensure that the insulation panels meet the current building regulations of 0.25 m2K/W with regard to both thermal properties and point loading characteristics. Edge insulation shall be installed to prevent losses through exterior walls.
The method used to hold the pipes to the insulation shall not compromise the effectiveness of the insulation or the vapour/damp proof membranes.
The insulation shall be an insulation panel with a patterned, laminated fabric polythene reinforcing foil. The foil shall be water resistant and complete with overlaps on two sides in order to cover the adjacent panel. Each insulation floor panel shall be taped and sealed on all sides to accept a liquid screed.
The Contractor shall be responsible for the co-ordination between the under floor heating specialist and the Main Contractor to ensure that floor insulation levels are maintained and that the under floor system is not left unprotected after laying.
Coil flow and return pipework passing through one zone to reach the controlled zone for which it is designed to heat must be insulated with a flexible proprietary pipework insulation system (9-12mm wall thickness) to prevent heat loss en-route to it's

destination.
Prior to and during the laying of the floor or pouring of the screed the floor coils shall be filled with water and subjected to a hydraulic pressure of twice the final system pressure.

2.10.8 Filling and Testing

When all the zones have been installed, the system shall then be filled and tested. The tests shall be witnessed and the appropriate paperwork and certification completed. The test pressure shall be 1·5 times the working pressure of the system or 3 bar, whichever is the greater.
The Contractor shall provide certificates for all tests, signed by all agreed parties. Systems shall be complete with all manifolds pipework, floor coils, water temperature control, room thermostats and ancillary equipment.

2.11 Radiators and Supports

All low surface temperature radiators shall comply with NHS Estates Health Guidance Note (March 1998). This shall be understood to impose a maximum surface temperature of 43°C. at any point on the case or grilles. Particular attention should be given to installing LST radiators strictly in accordance with the manufacturers recommendations. Any deviation can be detrimental to the output and surface temperature.
The Contractor shall check dimensions of all radiators before ordering to ensure they can be accommodated in spaces available.
All radiators shall be provided with air cocks and three air cock keys shall be given to the Client on Handover.
Radiators shall not have their tops protruding above the level of window sills. Cast iron radiators shall be free from hair cracking, scale and foundry sand.
Steel radiators shall be free from dents, bending, twisting and pinholes.
All radiators shall be constructed and tested in accordance with BSEN442, including a works pressure test to 1 bar and shall be in a primer or powder coat finish as detailed elsewhere. All visible supports, feet, brackets etc must be of the same finish as the radiator. Connections at an angle which throw the valves out of vertical alignment shall not be accepted. The Contractor shall include for taking all radiators down twice after erection for painting purposes and for re-fixing and leaving in sound working order. All radiators shall be without feet unless stated otherwise in the Particular Specification or in the Equipment Schedule.
All radiator supports must be neatly and cleanly made and fixed in true vertical and horizontal alignment. When necessitated by the building construction, all or most of the weight shall be carried by the floor on the manufacturer's radiator feet.
The number of bottom brackets provided shall be adequate for the length and weight of radiator as recommended by the radiator manufacturer. Cast iron radiators shall be provided with a mild steel top stay, either built into wall or secured thereto by screws in the case of woodwork. Steel radiators shall be supported from maker's standard concealed brackets.
In all cases where required to accommodate the expansion of movement of pipework, supports and stays must be of the type which shall allow completely free lateral movement. Failure to meet this requirement which may be disclosed after the application of heat to the system shall be rectified at the expense of the Contractor including the cost of any additional builder's work or other attendance involved.
Contractors shall ensure that all supports of any kind for radiators are adequately and securely fixed. Responsibility for all rectification involved in bad fixing of radiator supports shall rest solely with the Contractor.

2.12 Natural convectors

All natural convectors shall be constructed and tested in accordance with BSEN442, the heat exchanger being tested at works to a pressure of 1 bars, and the casings being primed at works. The temperature of the warmed air and surface temperature of the casing shall not exceed 43°C. All natural convectors shall be provided with concealed pattern air cocks. Each natural convector is to be fitted with a damper which is to be operated by a control lever on the front of panel of the convector. All natural convectors, whether of the wall or floor type, shall be securely fixed to the wall against which they are mounted. Trench heaters shall be set into a floor recess provided by the main Contractor. The Contractor is to forward the recess dimensions to the main Contractor. Where natural convectors shall be recessed, masking frames shall be fitted around the front plates.

2.13 Valves

Each radiator/natural convector is to be fitted with a wheel valve on the flow connection and a lockshield valve on the return connection, except where a thermostatic radiator valve is to be fitted to the flow connection. In this case a lockshield valve is to be fitted on the return connection only.
Trench heaters are to have full bore ball type valves fitted to F & R connections unless thermostatic valves are fitted. Thermostatic valves shall be of the straight or angle pattern type with remote sensors and capillary. Valves shall be fitted inside convector cases where possible.

2.14 Fan Convectors

Fan convectors shall be of a proprietary manufacture comprising filter, heating coil and fan assembly, with variable or 3 speed control, and installed where shown on the drawings to meet the performance criteria as detailed in the Equipment Schedules.
Units shall be horizontal or vertical as required. Air filter and heat exchangers shall be located on the inlet side of the fan and designed to give even air flow across the faces of the filters and heat exchangers.
Performance figures shall be obtained in accordance with BS 4856 and independently certified data and full manufacturers

technical details shall be submitted to the CA for comment prior to units are ordered. When appropriate, the CA shall be given the opportunity of inspecting completed fan coil units at the manufacturers works. Each fan coil unit shall be supplied with a minimum 2 metre length of flexible power cable. Ceiling mounted and free standing convectors which are arranged for reversed air flow, shall be provided with separate speed control, thermostat and on-off switch, as indicated in the Equipment Schedule for mounting remotely from the heaters by others. The temperature of the supply air and surface temperature of exposed casings within circulation areas and habitable rooms shall not exceed 43°C.

2.14.1 Casing

Casings for free-standing or exposed surface mounted ceiling type shall be of sheet steel and finished with stove enamelled semi-gloss paint finish to the Architect's choice of colour. All internal surfaces of the casings shall be fully lined at the manufacturers works and bonded to the casings in such a manner that the air flowing over the material cannot displace the insulation for the life of the fan convector. Insulation shall have a fire rating of not less than class "O" and be not less than 15mm thick. The insulation finished surfaces shall be smooth and robust and any mechanical fixings shall not create pockets or reduce the thermal and acoustic integrity of the insulation. Insulated access covers shall be provided giving full access to the fan, heat exchangers and filters for regular maintenance, cleaning and replacement. They shall be constructed of the same material and finished to match the casings and be designed and constructed in such a manner that they are unable to retain deflections when fitted to the fan coil unit with quick release fastenings. Front panels of all heaters shall be fitted with lockable insulated access covers and shall be give 1% air tightness when fixed in the closed position.

2.14.2 Air filters

Filters shall be the of a permanent and washable type and held in a lightweight frame and easily removable.

2.14.3 Air to water heater exchangers

Coils shall comprise straight aluminium fins securely bonded to copper tubes construction. Tubes shall have freedom to expand and contract in the frame and casing without damage. All coils shall be protected from damage and entry of dirt and water during the course of the contract. Before connecting the coils ensure that the connecting ductwork is clean. Access shall be provided on both sides of the coil for cleaning purposes. Heater batteries shall be pressure tested to 10 bars, and Fan Convectors shall be constructed and tested in accordance with BS EN 442. Where necessary for venting purposes, fan convectors shall be fitted with concealed automatic air vent or air cocks.

2.14.4 Fans

Fans shall be direct drive, forward curved, double inlet width centrifugal type with sealed for life bearings. The fan suction shall be designed to give an even air flow across the face of the heat exchanger. Fan motors shall be totally enclosed, external rotor type with built-in thermistor protection and shall comply with BS 2048 Pt 1, BS 5000 and BS EN 60034. Motors shall be suitable for 24 volts, single phase 5 Hz supply, power factor corrected to a minimum of .95 and suitable for speed control. Each fan shall have its own resiliently mounted motor. The fan and motor shall be statically and dynamically balanced. Required room noise levels and thermal duties shall be achieved when the supply fan is running at medium speed. Where room noise levels are not given, the measured room noise level shall not exceed NR 35 at 1.5m from the face of the air inlet and outlet grilles when the fan coil unit is running at medium speed. Noise levels shall be measured as part of the commissioning requirements.

2.14.5 Installation

Convectors shall be installed strictly in accordance with the manufacturer's instructions. Particular attention shall be given to prevent any transmission of noise or vibration to adjacent services and building structure. Pipework connections for free-standing fan convectors shall be arranged to be out-of-view and the control valves being within their casings. Control valves for ceiling mounted fan convectors shall be installed above the false ceiling.
Heating flow connection shall be fitted with a lever operated isolating valve and commissioning sets for low flow conditions shall be fitted on the return connection. A permanent bypass fitted with a lever operated isolating valve shall be installed between the flow and return to allow flushing of the system whilst bypassing the heat exchanger. Free standing fan convectors shall be mounted on plinths provided to the Installation Contractor's builders work requirements. The plinths shall be of at least skirting height, arranged to accommodate the connections. Provide and fix the necessary steelwork supports for ceiling mounted and bulkhead mounted Fan Convectors. A local switched fused connection unit shall be supplied and installed as part of the electrical installation. The Mechanical Contractor shall provide full electrical requirements to the Electrical Contractor at the same time as submitting the drawings to the CA for comment.

2.14.6 Controls

Electrical wiring for fan convectors shall be carried out by the Electrical Contractor with all associated controls, thermostats and sensors supplied "free-issue" by the Mechanical Contractor. Controls shall be to the minimum requirements as described below, and in addition, please refer to Automatic Controls, the Particular Specification and Equipment Schedules. All fan convectors shall be fitted with integral low temperature limit thermostats, to switch off fans in the event of the heater batteries not being up to temperature. Free standing and recessed fan convectors with the airflow in the rising direction shall be fitted with integral thermostats and switches for on-off and speed control detailed in the Equipment Schedules.

2.15 Unit Heaters

Provide and install in the positions indicated on the drawings, unit heaters of the make, type, sizes, fan speeds and emissions given in the Schedule Unit Heater. Unit heaters shall be fitted at the heights shown on the Schedule and are to have motors wound for the electrical supply given in the Schedule. In sports halls and in other cases where indicated on the drawings, unit heaters shall be protected from damage by wire mesh guards. These shall be sufficiently robust to prevent denting when struck by basketballs, cricket balls etc. Unit heater casings shall be sheet steel, primed at works, being fitted with maker's label giving the type, number and duty of the heater. Motor enclosures shall be of IP55 Class F insulation complying with BS4999 and IEC34. Provide and fix the necessary steelwork supports for each heater. Provide for fixing by the electrical sub-contractor, one control thermostat and one motor starter, of suitable types for the control of each unit heater. Provide and fix on unit heater and flow and return connections, wheel and lockshield isolating valves. Where necessary unit heaters shall be vented at high points with air bottles and cocks or automatic air vents as detailed in Section Pipework, Valves & Accessories.

2.16 Overhead Radiant Strip Heaters

Provide and fix in the positions shown on drawings, Overhead radiant strip heaters of the sizes, types, makes and emissions given in the Schedule of Radiant Strip. The radiant heaters shall be constructed from sheet metal, and shall incorporate tubular heating elements, the whole being powder coated to a RAL finish. The tops of the heaters shall be fitted with backing insulation. Joints between the sections of the heaters shall be fitted with cover plates to preserve the appearance of continuous strip. Radiant strip heaters shall be supported from manufacturers standard hanging brackets, fixed to the building structure. Any steelwork supports shall be provided by the Main Contractor.

Provide and fix wheel and lockshield isolating valves on the flow and return connections respectively of each run of strip heater. Where necessary, radiant strip heaters shall be vented at high points with air bottles and cocks or automatic air vents as detailed on the drawings and Particular specification.

2.17 Room Heating Coils

Heating coils tubes shall be heavyweight mild steel tube to BS21 & fittings to BS143 and be installed where shown on the drawings to the output duties given in the Equipment Schedules and be constructed for the working pressure and temperature of the heating system to which they are connected and shall be tested at works to twice the working pressure. They shall be fitted with drain cocks and air bottles and air cocks for venting purposes. Heating coils shall be coated in an anti-corrosion treatment coating ready for a final paint finish by others. Heating coils to be mounted in rooms at low level and below 2mm above finished floor level must be encased and fitted with suitable convector grilles to ensure the exposed surface temperatures do not rise above 43°C.

2.18 Heating Pipework

2.18.1 Heating Pipework Below Ground

Heavy quality seamless black mild steel tube to BS EN10255 (BS1387). Pipework of 65mm bore or over is to be welded and have flanged joints. Where welding is used, butt welded fittings are to comply with BS 1965 Part 1. Fittings: Malleable iron fittings to BS 143 having screwed joints of British Standard pipe thread to BS 21 & BS EN 10226.
Insulation to be CFC free blown polyurethane foam with thermal conductivity of not more than 0.032 w/mK. Exterior casing to be MDPE seamless extruded, colour black.

2.18.2 Fittings

Jointing seal to kit to incorporate HDPE over sleeve, heat shrink adhesive tape, sealing strips pour hole patches with adhesive backing, insulating polyurethane foam resin and activator.

2.18.3 Depth

750mm cover or as otherwise shown on the tender drawings. The complete system is to be designed by the specialist supplier to incorporate ground movement and thermal expansion stresses.
Wall bushes and shrink wrap end caps are to be used where applicable.
Trench excavation dimensions and reinstatement is to be in accordance with the pipe manufacturers requirements.
Marker tape must be installed 300mm above the entire length of the pipework. Prior to applying jointing kits the pipework system is to be water pressure tested to a pressure of 6 bar for four hours with no permissible pressure drop.

2.18.4 Heating Pipework Above Ground

Where specified in the particular specification: Steel Heavy quality black mild steel tube to BS EN10255 (BS1387). Pipework of 65mm bore or over is to be welded and have flanged joints. Where welding is used, butt welded fittings are to comply with BS 1965 Part 1. Fittings: Malleable iron fittings to BS 143 having screwed joints of British Standard pipe thread to BS 21.

2.18.5 Heating Pipework Above Ground

Where specified in the particular specification: Copper Copper Table X to BS 2871 Part 1 (EN 1057 R250). Fittings to be copper, lead free integral solder ring type complying with BS EN 1254 Parts 1 and 5.

2.18.6 Valves & Strainers

Type	Connection	Description
Ball valves	Screwed 15 to 50	Dezincification resistant, copper alloy, screwed, body and ball,
Filter type ball valves	Screwed 15 to 50	A dezincification resistant copper alloy body and ball, combined
Wedge gate valves	Screwed 15 to 50	Dezincification resistant copper alloy, screwed to BS 5154, non-
Wedge gate valves	Flanged 65 to 300	Cast iron, wheelhead pattern to BS 5150 inside screw, non-rising
Butterfly valves	Wafer type between	Cast iron or SG iron semi lugged wafer type generally to BS 5155
Regulation - variable &/or fixed orifice measuring facilities	15 to 50	Regulating disc, double regulating device, set point indicator, rising stem, screwed bonnet, metal to metal or PTFE seat on copper alloy valves, plus outside screw. Copper alloy trim and stainless steel trim on cast steel valves to BS 5154 screwed BS21 To include pressure tappings for flow measurement. Also suitable for ultra low flow measurement
Regulation	65 & above as per smaller sizes but flanged to BS 4504	
Check valves	Screwed 15 to 50	Dezincification resistant copper alloy, swing pattern to BS 5154,
Check valves	Flanged 65 to 300	Cast, iron swing pattern to BS 5153, bolted bonnet and bronze
Strainers	Screwed 15 to 50	Dezincification resistant copper alloy, 'Y' type, complete with
Strainers	Flanged 65 to 150	Dezincification resistant copper alloy 'Y' type, complete with
Strainers	Flanged 65 to 300	Cast iron, 'Y' type, complete with stainless steel screen, 1.6mm

Refer also to Section Pipework, Valves & Accessories

2.18.7 Application For Low Temperature Hot Water
(having maximum working pressure 3.5 bar gauge and temperature 95°C)

Provide valves and fittings of metric standard to a pressure/temperature rating of PN6 minimum for ferrous valves and PN16 series 'B' minimum for copper alloy valves. Products shall be BSI kite marked, where available, using approved manufacturers of BSI assessed capability in accordance with BS EN ISO 9000: Quality Management & QA standards. The type of operation i.e. lever, handwheel, shielded lockshield (square key or Allen key), shall be as detailed in the Particular specification, Equipment Schedules or shown on the tender drawings.

2.18.8 Radiator Valves

Dezincification resistant copper alloy to BS 2767, screwed B.S. 21 taper, complete with union nut and tailpiece. Handwheel and lockshield head in white or ivory-coloured, tough stain free plastic.
Finishes shall be polished chrome unless stated otherwise. Radiator valves shall be manufactured from cast gunmetal or bronze and comply with BS 2767, of straight or angle pattern as appropriate, with brass construction. Where copper or stainless steel pipework is used for the heating system, the connection of radiator valves are to have compression joints to BS 864 Part 2. Elsewhere radiator valve feed connections shall be female pipe threads to BS 21.

2.18.9 Thermostatic Radiator Valves (TRV)

Valves shall be suitable for the system temperature range with replacement head, stem, seal and valve seat, without shutting down the system, and capable of positive shut-off for isolation. Where thermostatic radiator valves are designed to be positioned in flow connections to the radiator fit a matching finish lockshield valve in the return connections. Before the thermostatic radiator valve fit a ball valve and concealed Allen key operated drain cock on the dead side of the isolating valve for radiator isolation and draining. Where main flow pipe is exposed under radiator, fit a thermostatic valve on the radiator top entry. Provide thermostatic radiator valves to BS 6284, and BS 21 with tape threads on both ports and complete with union nut and tailpiece.

2.18.10 Identification and Plant Labels

Refer to Section Labelling and Identification.

2.18.11 Testing and Commissioning

Refer to Section Testing and Commissioning.

2.18.12 O & M Manuals and Record Drawings

Refer to Section Operating & Maintenance Instruction Manuals and Record Drawings and the Particular Specification.

2.19 Hot and Cold Water

2.19.1 Scope

Hot and cold water systems shall comprise all necessary pipework, isolating and balancing valves, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings, Specification, Appendices and tender drawings. Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.19.2 Pressure Vessels

On completion of the installation the Contractor shall provide to the Employer's insurance company all information on the system expansion vessel as is required under Statutory Instrument No.2169 'The Pressure Systems and Transportable Gas Containers Regulations 1989'. The Contractor shall obtain from the insurance company a certificate for the installation and this shall be included in the O & M Manual. A written scheme for working on the vessel(s) shall also be included in the O & M Manual.

2.19.3 Hot Water Boilers

Hot water boiler(s) must be installed strictly in accordance with the manufacturers instructions and shall be commissioned and set to work by the manufacturer's engineer or appointed agent. The commissioning certificates shall be included in the O & M manual and laminated and fixed securely in the respective boiler room. Direct fired hot water boilers shall be suitable for floor standing complete with mounting frame and manufactured to the highest standards using the latest product technology, high quality of construction and finishes producing long lasting high efficiency performances enabling the unit to meet the hot water demands for the life of the building. The boiler(s) shall be compliant to EU Directives, British Standard specifications and Water Regulatory Advisory Scheme (WRAS) approved. The Contractor shall provide the Main Contractor with a detailed drawing showing the required boiler bases and openings required in Builder's Work chimneys. The Contractor is responsible for checking that these are provided in accordance with his detailed drawings. Boilers shall be provided with makers standard casings, insulation, controls and instrumentation, and shall be suitable for the working pressure of the system. Where gas fired boilers are installed, whether fitted with forced draught or natural draught burners, a gas leak detector system is shall be fitted in the boiler house, as detailed elsewhere. All condensing boilers shall include a condense connection. Condense shall be carried away from the boiler to the buildings drainage system via suitable plastic pipe. Under no circumstances shall copper or steel pipe be used.

2.19.4 Construction

The water heater cylinders shall be high grade stainless steel and coated with a high quality vitreous enamel lining. The cylinder or hot water storage vessel shall be welded construction prior to the glass lining being applied, ensuring that the integrity of the lining is maintained during manufacture.
The glass coating shall be applied after manufacture in a manner to ensure an even coating throughout. surplus material shall be drained before the baking process to adhere the lining to all surfaces of the cylinder.
The cylinder shall be insulated with minimum 50mm thickness CFC free foam insulation. The standing losses from the cylinder shall exceed the minimum required in Part L of the Building Regulations. All joints shall be rendered air-tight, to prevent air from entering and gases from leaking from the combustion chamber, flue-ways and smoke connections. Cylinders having a storage capacity greater than 200 litres shall be fitted with access hatches to enable removing of scale and internal cleansing of the unit. All multi-tube construction water heaters shall have two such access covers incorporated in the water heater tank to allow easier maintenance. Access hatches and plates covering orifices into the combustion chamber are to close tightly, and shall be free from warping.

2.19.5 Burners

Burners shall be provided as either an integral part of the boiler assembly or be a manufacturers matched component t as detailed elsewhere. The completed installation shall give full access to the burner(s) for regular maintenance, cleaning and removal.

2.19.6 Heat Exchanger

Multiple or single vertical fire tubes, depending upon the size of the unit, shall be fitted at equal spacing centrally within the cylinder. Each fire tube shall be fitted with a steel baffle to maximise heat transfer.

2.19.7 Gas, Oil & Flue Connections

All gas, oil and flue connections shall be installed in accordance with the Sections on Gas, Oil and Flueing Systems and as detailed elsewhere.

2.19.8 Plant Room Ventilation

All required ventilation for combustion shall be installed by the Contractor to comply with the Gas Regulations and as detailed elsewhere.
Where heating plant is installed in plant rooms where ventilation is not required for combustion, adequate natural or mechanical extract ventilation shall be provided as detailed elsewhere. Where ventilation requirements are not specified, the Contractor shall bring this to the CA's attention for clarification prior to installation works proceeding.

2.19.9 Sacrificial Anode Protection (mild steel or glass lined only).

All cylinders shall be fitted with a sacrificial anode or element to protect the unit from corrosion when an electric anode protection system is specified, then an uninterrupted power supply must be provided. Specific allowance must be made for anode/ element replacement. The vessel shall be high grade stainless steel. There shall be no sacrifical anode and manufacturer shall guarantee the vessel for 25 years.

2.19.10 Thermostatic Controls

All water heaters shall be fitted with a close control electronic thermostat to control to + or – 2.5°C. The leaving water temperature shall be maintained at 60oC. All vessels shall be protected from high temperature using an electrical non self-resetting thermal cut-out to prevent continual heating of the water to temperatures above 95oC. Alarms shall be relayed to the central control system as detailed elsewhere. Frost protection shall be provided initiating firing when the stored water falls below 20°C. Thermostats shall be calibrated in degrees Celsius and be tamper proof and only adjustable by authorised personnel.

2.19.11 Time Switch Controls

Water heaters serving buildings which are in use or open either during normal working hours or during education term time (i.e. less than continuous 24 hour operation) shall be fitted with an electronic 365 day programmable time switch. The programmer shall be set according to the Client's annual requirements plus an agreed warm- up period prior to usage to enable the stored and circulated water Health and Safety Commission publication "Legionnaires' Disease the control of Legionella bacteria in water systems" L8 (Para 154) If a calorifier or any substantial part of a hot water system is on standby use or has been taken out of service for longer than 1 week, the water in the calorifier should be brought up to 60°C for 1 hour before being used; this should be measured with normal circulating pumps operating and not with the system in a stagnant state. If there are standby re-circulating pumps on the hot water circuit, they should be used at least once per week.
In any establishment, where the water is going to be switched off during 'holiday' periods, it is important that the building manager is made aware of this requirement. The calorifier temperature must reach 60°C BEFORE the 1 hour is commenced, and the flushing of the system, i.e. taps and showers, should not be done until AFTER the hour with the calorifier maintained at 60°C.

2.19.12 Sealed Hot Water Systems

Sealed systems shall be complete with an unvented kit comprising isolation valve, pressure reducing valve, expansion relief valve, expansion vessel (if not contained within the vessel) temperature and pressure relief valves as detailed elsewhere. Expansion vessels shall comply with BS 4814 and be sized to account for full system expansion at the specified settings and shall be closed with non-ferrous linings of the size, type and make as detailed elsewhere. An air separator, incorporating an automatic air vent of the size, type and make shall be fitted in main flow connection from each vessel of sealed or pressurised systems, An anti-vacuum valve shall be fitted to prevent possible vacuums being caused when drained and subsequent collapse shall be fitted to the boiler during manufacture. A suitably sized pressure and temperature relief valve shall be fitted locating directly into the hot water storage vessel. Unvented water heaters shall only be installed by appropriately trained and qualified competent persons holding a current registered operative identity card from an approved body (i.e. CITB or equivalent body).

2.19.13 Connections & Pipework

All vessels shall be provided with tappings to suit the pipe connection.
A tapping for the secondary return circulation shall be located just above the cold feed connection at low level on the boiler. The cold feed shall be designed and installed to prevent heat travelling through the cold water by convection when there is no flow. A non-return valve shall be fitted on the cold feed and in the return pipe of circulation systems, the valves shall be within 300mm of the heat exchanger.

Pipework shall be installed so as not to obstruct access hatched.
Pipework shall also be arranged to allow ready disconnection and complete removal without damage to casing, insulation or undue disturbance to the pipework. Unions on pipework shall be positioned as close as practicable to the cylinder or calorifier to facilitate removal with the shortest practicable lengths of tube attached.

2.19.14 Maintenance

Sufficient clearance shall be provided around the water heater to permit efficient application of insulation or its subsequent repair or renewal and to allow access to all parts of the vessel including all valves and fittings for maintenance, replacement and must take account of the minimums specified by the Manufacturer.

2.19.15 Cleaning Tools

Provide with each boiler a full set of cleaning tools and brushes which shall be mounted on a board in the boiler room.

2.19.16 Cylinders and Calorifiers

Storage and non-storage calorifiers shall be horizontal or vertical design complying with BS 853 grade B for shell operating temperatures not exceeding 90°C and tube pressures not exceeding 4.5 bar, otherwise to BS 3274: Type 2 or BS 853 grade A for higher pressures and temperatures. Vessels shall be capable of working under the static head produced by the system without any adverse affects to the vessel.
Non high pressure systems, the body of the vessel shall be constructed from cold rolled half hard copper with welded seams. High pressure the body of the vessel shall be constructed from high grade stainless steel. The thickness of the steel/copper shall be as recommended by the manufacturer to suit the volume and system working pressures.
The ends shall be worked up to the correct camber before welding to the body, all joints are shall be zinc free. All calorifiers shall be fitted with an anti-vacuum valve.
All secondary hot water services connections are shall be screwed metric or welded in accordance with the pipework, valves & accessories section. The connections shall extend through the lagging with outer cover nuts as required.
Heat exchanger bundles shall be constructed from solid drawn copper “U” tubes expanded in a tube plate to BS 2871 with a suitable header, forming a battery which is easily withdrawn though a flanged neck.
Shells shall be fitted with a suitably sized access hatch for inspection and cleaning.
Vessels shall be designed shall be supported on fabricated feet attached to the shell to enable drainage shall be carried out or on separate cradles or frames with not less than 300mm clearance under the drain valve or horizontal calorifier. Neoprene sheets shall be fitted between the shell bearing surface and any separate supports. Horizontal calorifiers and cylinders shall be inclined towards the drain cock at the heater battery end at a gradient of not less than 1:60. Drains shall be of a size to enable emptying the contents in 30minutes or less.

2.19.17 Scale Protection

All vessels shall be fitted with in-line scale inhibitors of the size of the connection to the heater in accordance with the make, type and size as shown on the drawings and as detailed elsewhere. (mild steel or glass lined only). All cylinders shall be fitted with a sacrificial anode or element to protect the unit from corrosion when an electric anode protection system is specified, then an uninterrupted power supply must be provided. Specific allowance must be made for anode/ element replacement. The vessel shall be high grade stainless steel. There shall be no sacrifical anode and manufacturer shall guarantee the vessel for 25 years.

2.19.18 Access

Water heaters and calorifiers shall be fully accessible and located in rooms or cupboards designed accordingly. Heating plant and apparatus fitted in roof voids or above internally partitioned rooms or the like, walkways and adequate working platforms shall be provided by others to allow safe access for maintenance and replacement. Sufficient clearance shall be provided around the plant to permit efficient application of insulation or its subsequent repair or renewal and to allow access to all parts of the vessel including all valves and fittings for maintenance, replacement and must take account of the minimum special requirements specified by the Manufacturer. All vessels shall be provided with tappings for connections as shown on the drawings and for all mountings/fittings as detailed elsewhere.. Secondary return circulation shall encompass full volume of all pipework and vessels fitted in each system.

2.19.19 Boiler, Cylinder and Calorifier Mountings

A non-return valve shall be fitted on the cold feed and in the return pipe of circulation systems, the valves shall be within 300mm of the heat exchanger. Facilities shall be provided within the manufacture of hot water boilers, cylinders and calorifiers to enable the following minimum fixings:

i. Pockets for temperature controls

ii. Dial thermometer of 100 diameter calibrated 0 to 120°C with divisions at 1°C intervals and numbered at 10°C intervals with bold figures, complete with a separate pocket to suit the immersion position. A separate red indicator shall show the normal temperature setting.

iii. Altitude or pressure gauge of 100mm diameter, white faced with black figured scale, calibrated both in bar (or kPa depending upon the range) and metre head, to approximately twice the working pressure. Complete with level handle gauge cock and adjustable red dial pointer set at the normal working pressure or head of the system, generally to comply with BS 1780.

iv. Safety temperature & pressure relief valve to BS 759, enclosed spring loaded pattern, fitted with a padlock, and a copper discharge pipe run clear of any insulation, to terminate 150mm above floor level over a drain gulley.

v. Drain cock of the bronze gland type with loose key and hose union tail.

vi. Open vent pipe connection (for open systems) separate from the cold feed

vii. Stamped, engraved, or cast-metal fixed identification plate clearly showing:- Manufacturers name and address Date of manufacture Hydraulic test pressures Maximum working pressure Rated capacity and output

2.19.20 HWS Circulators (pumps)

Hot water circulating pumps (secondary and destratification) shall be WRAS approved single headed type of the following materials: Pump housing : Brass Motor housing: Aluminium alloy Impeller : Stainless/composite Split cone : Stainless BS1449 Spherical can : Stainless steel BS 1449 'O' Rings : EDPM rubber Bearings : Tungsten carbide Each pump shall be capable of performing the duty given as detailed elsewhere and shall be fitted with a name-plate giving the following details:

• Manufacturers name
• Volume Flow Rate (l/s)
• Developed Pressure (Pa)
• Pump Speed (rev/s)
• Manufacturers Reference Each pump motor shall be fitted with a name-plate giving the following minimum particulars:
• Manufacturers name
• Motor reference numbers
• Details of electrical supply
• Motor speed (rev/s) A spare HWS circulating pump of the same size and type shall be left on site secured to the wall of the plant room adjacent to the working pump for use in case the working pump should fail.

2.19.21 Trace Heating

Where dead legs are greater than two metres in length and secondary circulation is not practical, a proprietary trace heating system shall be installed with the pipework insulation to automatically maintain 55°C. Trace heating shall be of the make, type, size and duty as detailed elsewhere.

2.19.22 Science Classrooms and Laboratories

Water services for these rooms shall be designed and installed to comply with the Water Regulations category 5.

2.19.23 Under-Sink and Multi-Use Water Heaters

The water heaters shall be unvented type, but able to serve more than one outlet without use of vented taps. Water heaters shall incorporate the following features:

• 2.2 kW to 4.5 kW corrosion resistant alloy element
• External temperature control (10-65°C)
• Glass enamelled steel, working pressure 6 bar maximum
• Over temperature cut-out (manually re-settable)
• Expansion relief and check valve fitted to cold inlet all enclosed in casing
• Pressure reducing valves fitted to main line
• Polyurethane foam insulation (CFC Free)
• Casing - steel with plastic top and bottom
• Finish white stoved enamel
• Suitable for working pressure of 3.5 bar
• Water connection 15mm and 22mm

• Max water capacity 15 litres

2.19.24 Cistern Type Water Heaters

Cistern type water heaters shall only be used where the hot water outlets are not required to be controlled to a low safe temperatures and shall not be fitted with a thermostatic mixing valve in accordance with below. Cistern water heaters shall not be used to serve cleaners sinks, classrooms, laboratories, kitchens and laundries. Where approved for use, they shall be fitted to a minimum height of 1.2m above the level of the taps or pipework for which they serve allowing for all maintenance requirements of the water heater. The float valves within cistern type water heaters shall each be suitable for the pressure of the water supply to which it is connected. All water heaters are shall be fitted with adjustable water temperature control and high temperature cut out thermostats. The cold water supply serving these units must be fitted with an electronic water scale inhibitor, see section below.

2.19.25 Instantaneous Point of Use Water Heaters

The use of instantaneous point of use water heaters shall only be applied where no other alternative means of providing hot water can be safely supplied. The cold water supply serving these units must be fitted with an electronic water scale inhibitor, see section below.

2.19.26 Cold Water Supply Booster Sets

Booster pumps shall be WRAS approved capable of performing the duty given as detailed elsewhere and shall be fitted with a name-plate giving the following details:
• Manufacturers name
• Volume Flow Rate (l/s)
• Developed Pressure (Pa)
• Pump Speed (rev/s)
• Manufacturers Reference Each booster set motor shall be fitted with a name-plate giving the following minimum particulars:
• Manufacturers name
• Motor reference numbers
• Details of electrical supply
• Motor speed (rev/s) A water presence sensing device is shall be incorporated in the suction pipework of the pressure set, arranged to prevent the pump(s) from running without water. A control box, containing a main isolator, pump starters, alarm, water level control relay and pump changeover switch, for duty and standby sets when specified, by the shall be incorporated into each pressure set. Each pressure set is shall be self contained, being mounted on a steel base-plate and framework. An appropriately sized accumulator vessel shall be fitted adjacent to the booster set of a make, type, and size. Where a pressure set feeds a hot water system, a double check valve shall be positioned in the cold feed from the pressure set to the water heater and an expansion vessel shall be fitted. Boosted water supplies shall be fitted with a pressure reducing valve of a size and type specified elsewhere.

2.19.27 Water Storage Tanks

Water storage tanks shall be manufactured from glass reinforced plastic and of the factory insulated type that does not require additional insulation when fitted on site. All water storage tanks shall be fitted with a float ball valve or other type level control valve (with suitable a air gap in accordance with the water regulations) as detailed elsewhere to control the water level within the tank. The Contractor shall install an isolation valve in the feed pipe as close as practicable to the tank. Each cold water service outlet or cold feed outlet from each tank is shall be fitted with an isolation valve as close as practicable to the tank. Where two or more tanks are connected into the same hot or cold water service system, the tanks are shall be of the same height, are shall be fitted at the same level, and shall be piped together to ensure that the cold water draw off cannot be greater through one thank than the other. Tanks will be installed is such a way that potable water can be maintained and will include screen gauze filters (of 0.65mm mesh) on the air inlets, overflows and warning pipes. A sealed lid and shall be fully insulated to prevent warming or freezing and shall be secured with stainless steel bolts or screws and incorporate an air tight seal which excludes light or insects. Larger tanks, greater than 1000 litres shall be fitted with an access hatch in the lid directly over the ball valve/level control valve to allow for inspection of the internal surfaces and large enough to permit maintenance of the valve without removing the whole lid. The inspection hatch will be sealed and screwed down in similar fashion to the tank lid.

2.19.28 Overflows

Overflows shall be run in accordance with the current water regulations. Cold water storage tanks other 100 litres shall be fitted with both an overflow to a drain and a warning pipe that shall terminate in a clearly visible location. Open vent pipes from tank fed vented hot water heaters should discharge into a suitable tundish fitted adjacent to the cold water storage tank from which it is fed and not directly into the tank. This is to prevent hot water entering the cold water storage tank via the open vent. The tundish shall be connected to pipework of adequate diameter and shall discharge to a safe external location. The discharge pipe shall terminate in a clearly visible location.

2.19.29 Water Saving Urinal Flush Control

Each urinal cistern shall be fitted with a self acting control on the water inlet. The unit shall be to the Water Research Centre's requirements. The control shall be sensitive to pressure variations in the distribution pipework to detect building occupancy. Alternatively, detection may be carried out electronically, where agreed by the CA. When the building is occupied the control shall allow the flushing cistern to operate. An adjustment shall be incorporated to allow the flushing rate to be set. Electronic urinal flush control with PIR 'on-pipe-sensor' or 'remote sensor' activation to each urinal flushing cistern shall be fitted in toilet areas of the make, type and size as detailed elsewhere and in accordance with the current water regulations.

2.19.30 Water Treatment - Water conditioners or Scale Inhibitors

When Electronic water conditioners are specified to be used (see Equipment schedules and drawings) they shall be selected to suit the size of the installation and installed on the cold water in a position as recommended by the manufacturer. A 240 volt dedicated power supply shall be included from the local power distribution board serving a local un-switched fused connection unit. Plant or power failure shall be relayed to the automatic control panel to raise an alarm. Pipeline type scale reducing devices and water softeners shall not be fitted with a by-pass line . Fit to each side of the scale reducer isolation valves to facilitate the removal or replacement of the device.

2.19.31 Flushing and Chlorination of Services

All pipework carrying water shall be thoroughly flushed with clean water and all filters, strainers and the like removed and cleaned as part of this process. Domestic hot and cold water systems shall be cleaned and chlorinated in accordance with the Section Inspection, Testing and Commissioning.

2.19.32 Cold Water – Application

For mains and pumped potable cold water having maximum working pressure up to 16 bar gauge and temperature 3 to 20°C. Provide valves and fittings to metric standard to a pressure/temperature rating to PN16 minimum for ferrous valves and PN16 series 'B' minimum for copper alloy valves. Products shall be BSI kite marked, where available, using approved manufacturers of BSI assessed capability in accordance with BS EN ISO 9000: Quality Management & QA standards. Provide Water Research Centre valves with parts in contact with the water constructed from dezincification resistant materials. Refer also to Section Pipework, Valves & Accessories and Particular Specification.
~~Reduced pressure zone (RPZ) valves RPZ valves shall be installed to meet the requirements of category 4 of the Water Regulations to protect against contamination risks, prevent back-syphonage and back pressure. These valves shall only be installed when there is no alternative and specifically required by the Area Water Supplier and agreed with the Client and Engineering Design Practice Ltd.~~ Pressure reducing valves, thermostatic mixing valves, pressure and temperature safety discharge valves, anti-vacuum/non-return valves ~~and RPZ (Reduced Pressure Zone~~) valves must all be accompanied by 'certificates of conformance' for inclusion in the operation and maintenance manuals for all services. ~~Full details of RPZ valves shall be included within the O&M Manual complete with manufacturer's test certificates and annual maintenance/inspection record sheets. Laminated copy of the certificates shall be fitted in an accessible location adjacent to the respective valves fitted. Settings of valves shall be calibrated to work at the correct pressure or temperature in accordance with other embedded equipment being used, manufactures settings and as detailed elsewhere by the CA. Generally RPZ valves shall be avoided by installing to meet Category 5 requirements. The contractor shall request clarification prior to orders being placed or system design and working drawings being completed.~~

2.19.33 Hot Water – Application

For hot water and cold water internal domestic shall be selected from WRAS approved products and have a maximum working pressures up to 10 bar gauge and temperature up to 65°C and intermittent temperatures up to 90°C for pasteurisation. Valves and fittings shall be metric standard to a pressure/temperature rating of PN10 minimum for ferrous valves and PN16 series 'B' minimum for copper alloy valves. Provide Water Research Centre (WRC) Listed valves with parts in contact with the water constructed from dezincification resistant materials. Variable orifice regulating valves shall comply with BS 7350: Specification for double regulating globe valves and flow measurement devices. The type of operation i.e. lever, hand wheel, shielded

lockshield (square key or Allen key), shall be as detailed elsewhere. Refer also to Section Pipework, Valves & Accessories.

2.19.34 Thermostatic Balancing Valves

All secondary circuit returns shall be fitted with multi-functional thermostatic circulation control valves. The valves shall be accessible and located as close to the connection to the hot water flow as possible. Thermostatic control valves shall:

- be adjustable to automatically limit the circulation flow to a minimum in and achieve a set minimum constant return temperature of 55°C without external power.
- be able to pasteurise the system to a temperature of 75°C for thermal disinfection and flushing to eradicate Legionella bacteria.
- be isolatable for maintenance with easily replaceable thermostatic cartridges.
- have a temperature monitoring point for use with a probe and an option for a gauge shall be fitted.
- be tamperproof once set.

~~2.19.35 Flow Regulators~~

~~All draw-offs shall be fitted with full bore, slot-top type positive shut-off ball isolation valves incorporating flow regulators. Flow regulators shall only be fitted once the new HWS and MWS have been thoroughly flushed through to system with pressures in excess of 1 bar. The following flow regulators are shall be used: Basins, sinks, dishwasher & water boiler – 8 litres/min (white) WCs – 6 litres/min (grey) - the above rely on pressure of 1 bar and above.~~

2.19.36 Thermostatic Mixing Valves

Only Type 3 thermostatic mixing valves manufactured in accordance with the NHS Estates D08 standard for mixing valves for use within health care premises in the United Kingdom shall be used. These valves shall be fully thermostatic to closely control the water temperature and quickly shut-off the outlet flow if either the hot or cold inlet supplies fail. Valves shall be locked after setting to prevent unauthorised adjustment. In addition hot water supply pipes to the TMV's shall be protected as these are classed as hot surfaces if accessible. Domestic hot water blending valves shall be thermostatically controlled to provide a constant HWS outlet temperature. Manual adjustment shall be key operated only. The body shall be manufactured from gunmetal with internal parts of stainless steel or corrosion resistant materials. Inlet connections shall be provided with lockshield pattern stopcocks and check valve assembly complying with the water bye-laws. Units exposed in rooms shall be chromium plated.
Units up to and including 50mm diameter shall be provided with integral unions on each connection and shall be screwed. Larger sizes shall be provided with flanged ends. All thermostatic mixing devices shall be fitted with isolating valves and cylindrical type strainers on the hot and cold inlet connections. These are shall be full bore lever ball valves only and of the lockshield type or screwdriver slot as given on the drawing or Schedule.

2.19.37 Thermostatic mixing showers (TMS)

Each valve shall be set to a maximum outlet draw off temperature of 41°C. All fittings (valves, stopcocks, shower fittings, brackets, supports and sprays in showers and shower areas) are shall be chromium plated as detailed elsewhere.
All surface mounted shower pipework and equipment shall be vandal resistant pipework being supported by built in ring clips at frequent intervals to enable pipework to take the weight of users. Alternately pipework may be concealed in impermeable tamperproof compartments, ducting or casing so as to prevent vandalism, whilst maintaining future access required for valves, pipework or fittings.

2.19.38 Safety Valves and Discharge Pipework

Safety valves shall be of gunmetal or bronze construction with diaphragm protected working parts and PTFE or EPDM to metal seating either NABIC or Bailey Birkett manufacture. All wetted parts are shall be manufactured from dezincification resistant materials approved by the Water Research Centre for use on potable water, inlet and outlet connections shall be of equal size, with female threads. Where fitted, lead seals on the setting mechanism shall be intact as supplied by the manufacturer. To prevent unnecessary operation of the valve, there must be an adequate margin between the set pressure of the safety valve and the normal working pressure of the system. The set pressure shall be at least 10% above the system working pressure, with a minimum margin of 0.7 bar for water and liquid applications. Final selection of the safety valve and its setting will depend on the application and system components selected. The set pressure of a safety valve must not exceed the design pressure of the vessel or system being protected.

2.19.39 Installation

Discharge vent pipework from water heaters, pressure vessels, unvented water heaters and other devices shall be via a tundish to a safe location in accordance with section G3 of the building regulations. In general this will be either to a drain via a trapped gulley or to a safe external location at low level terminating 100mm above ground level and shall be protected by a galvanised

steel cage to prevent access and scalding in the event of a discharge. In a plant room discharge pipework shall be to low level and terminate 100mm from the finished floor.

Discharge pipework shall be as short as possible, with a cross sectional area at least equal to that of the safety valve outlet. There shall be no flow restriction or isolating valve fitted to the discharge pipework and capable of withstanding the temperature of the discharged water. Discharge pipes must be installed with a continuous fall to facilitate removal of the discharged water. Discharge pipes must be clearly visible at the discharge point and at the tundish where one is fitted.

Before installation, all inlet pipework should be thoroughly cleaned and blown through to remove any particles or foreign matter. Inlet and outlet pipework should be of sufficient strength to withstand the reaction forces created when the safety valve discharges. It should be installed in such a way that no undue stress or vibration is transmitted to the valve.

Protective caps should not be removed from the safety valve until immediately prior to installation. The valve should be mounted vertically with the test level uppermost. The safety valve inlet connection should be attached to the vessel or pipeline using the shortest length of pipe, with no intervening stop valve. Inlet pipework must have a cross sectional area at least equal to that of the safety valve inlet. Where the pipework is flanged,it must be flat and fitted with a full face joint.

For temperature relief valves, the temperature sensing element must be installed in the top 150mm of the heater when installed, with no fouling of the thermal element or restriction of flow. Any safety valve shall be supplied with a valid pressure test certificate (PED) and letters of conformity from the manufacturer. These shall state the system working pressure, set pressure and date of testing. These certificates shall be plastic laminated and mounted within the plant-room or locally to the safety valve. A further copy of the PED certificate shall be provided in the O&M manual.

All safety valves shall have galvanised steel or copper overflow pipe carried clear of the hot water vessels insulation and turned over to discharge downwards no more than 100mm from the floor. Keys for padlocked valves shall be handed over to the Client. All valves shall be suitable for the type of system, i.e. vented or sealed pressurised systems and shall be manufactured by NABIC or equal approved.

The Contractor shall obtain from the insurance company a certificate for the installation and this shall be included in the O & M Manual and mounted in the plant room locally to the respective safety valve. A written scheme for working on the vessel(s) shall also be provided in the O & M Manual.

2.19.40 Pipework and Fittings

Hot water service

Below Ground Pipework Pre-insulated cross linked polyethylene with protective sheathing Fittings Screw and press type Depth 750mm cover with inspection chamber at each joint

Above ground Pipework Light gauge copper tube of Table X to BS EN 1057 Fittings Copper capillary fittings to EN 1254 Parts 1 and 5 lead free solder

Cold water down service

~~Below Ground Pipework Pre-insulated cross linked polyethylene with protective sheathing Fittings Screw and press type Depth 750mm cover with inspection chamber at each joint~~

Above ground Pipework Light gauge copper tube of Table X to BS EN 1057 Fittings Copper capillary fittings to EN 1254 Parts 1 and 5 lead free solder

Mains water service

Below Ground Pipework MDPE – blue rating SDR 11

Fittings Fusion welded Depth 750mm cover with warning tape and tracer cable

Above Ground Pipework Light gauge copper tube of Table X to BS EN 1057 Part 1 Fittings Copper capillary fittings to EN 1254 Parts 1 and 5 lead free solder

Shower Pipework

Pipework Chromium plated copper tube

Closure Plates

Material Plastic or chrome plated for chrome pipework

Taps and outlets

Final connections shall be run in light gauge copper tube, and are to include a union joint to facilitate disconnection. Flexible hoses for final connection are not permitted whatsoever – Pipework to be solid copper tube throughout.

~~**Laboratory taps**~~

~~Laboratory taps fitted to teaching classroom or laboratory sinks shall be fitted with WRAS approved backflow prevention devices. Written approval from the respective Water Company shall be obtained and bound into the operation and maintenance instruction~~ manual.

2.20 Gas (Natural and LPG)

Gas systems shall comprise all necessary pipework, isolating and balancing valves, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings, Specification and tender drawings. Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.20.1 Installation personnel

The installation shall be carried out by competent employees who have adequate training and experience. Training shall be in accordance with the HSE Standards of Training in Safe Gas Installations. The one or more Contractors personnel shall be a member of Gas Safe or other body approved by the Health and Safety Executive and be responsible for the installation.

2.20.2 Gas Entry to Buildings

The entry to the building of the gas pipework from underground shall be as follows: Within the building in a pit sealed from the underfloor space and on completion of the pipework the pit shall be filled with sand. A manual isolating valve shall be supplied and installed at the entry to each building.

2.20.3 Secondary Gas Meters

A notice shall be provided and securely fixed at all primary gas meters stating the number and location of secondary gas meters together with a schematic drawing. At the location of secondary gas meters a notice shall be provided and securely fixed stating the location of the primary meter.

(Where specified in the particular specification) Secondary gas meter shall be fitted, to separately serve commercial appliances as follows;

- Hot water boilers
- Kitchens
- Laundry equipment.

All secondary gas meters shall:

- Comply with British Standards BS 6400 BS EN 12261 and BS EN 12405 as applicable
- Meet the conditions of 500mbar and -20°C to +50°C
- Be fitted with swivel nut or PN16 flanged flexible connections to BS4504
- Be located in an accessible position and adequately ventilated space
- Be fitted with low frequency reed switch or other appropriate means to provide a pulse output for connecting to a BMS system for remote monitoring.
- Be fitted with inlet and outlet shut off valves.

2.20.4 Gas Pipework for LPG and Natural Gas

Below ground The PE pipework shall be laid 900mm deep (or as shown on the tender drawings) onto a 100mm thick bed of fine graded sand, covered with a further 100mm of fine grade sand. The Contractor shall be responsible for ensuring that the civils work is carried out to fulfil the requirements of this specification.

In order to ease construction on site and to simplify the coordination of underground services, all services pipework shall be laid at the one level, determined by the deepest buried service whilst maintaining the required clearances at all times. Joins in underground pipework will not be permitted unless practically unavoidable.

The external underground mains gas service pipe shall have polyethylene marker tape 150mm wide overlaid through its length. The marker tape is to be yellow with black lettering indicating Caution – Buried Pipes Below signifying Mains Gas and shall have tracer wire integrated into the tape. The tracer wire shall terminate at the point of entry to the building with a junction box on the wall 150mm above ground level. All underground pipework shall be pressure tested prior to back filling.

Materials:

MDPE yellow
Pressure rating Natural Gas: SDR 17.6 at max working pressure of 3 bar.
LPG: SDR11 at maximum valve pressure of 5.5 bar
Fittings Fabricated electro-fusion or pupped type to BS 7336
Jointing Electro-fusion welded to BS 7336

2.20.5 Gas pipework for LPG and Natural Gas

Above ground Steel:

Jointing up to and including 50mm : Threaded to BS21 ISO R7
Welded fittings to BS 1965
Fittings to BS 143 and 1256 and BS 1740 Part 1 Flanges (welded or threaded) to BS10, BS160 and BS 4504.
Suitable jointing compound or PTFE tape to BS 5292 to be used. Hemp must not be used
Above ground Corrosion protection:
Pipework and fittings cleaned and 1 No. coat red oxide primer applied.
Top coat of yellow ochre to BS 08C 35 applied.
Pipework to be labelled with gas identification tape.
Jointing 65mm and over :Welded fittings to BS 1965
Flanges welded to BS10, BS 1560 and BS 4504

Copper In accordance with installation standards

Material Half hard light gauge copper tube to EN 1057 – R250 Table X
Soft coiled tubes to EN 1057 – R220 Table Y (LPG only)
Above ground corrosion protection:
Where applicable factory sheathed “Kuterlite” sleeve or bitumastic paint yellow ochre to BS 08C 35.
Pipework to be labelled with gas identification tape.
Jointing Integral solder ring (SIR) capillary fittings to BS EN 1254 Part 1, BS 864 Pt 2. Jointing flux to be of a non-corrosive nature with all excess solder/flux residues removed after jointing.

2.20.6 Gas Valves

Provide British Gas listed valves and fittings to metric standard to a pressure/temperature rating of PN6 minimum for ferrous valves and PN16 Series 'B' minimum for copper alloy valves.
Valves in accordance with British Gas Publication IM/15 and approved for use in the specified application. Fire resistant construction in plant rooms and fire risk areas.
Valve end connections for polyethylene pipe to suit fittings to BGC/PS/PL3.

2.20.7 Manual Isolating

Isolation valves on gas pipework or at equipment for sizes up to 50mm diameter shall comprise lever operated plug valves. Valves shall be manufactured from cast gunmetal or bronze with taper plug and screwed ends. 65mm diameter and larger sizes shall be lever operated lubricated plug valves. Valves shall be manufactured from cast iron with taper plug and flanged ends. Each valve shall be provided with a lever or wrench which shall be fitted so that it lies parallel with the pipe when the valve is open.
Gas valves shall comply with the IGE/UP/2 current edition and the Section Pipework, Valves & Accessories and shall also:

- Comply with the applicable British Standard and be designed as suitable for gas.
- be located in readily accessible locations.
- all valves shall be selected as fit for purpose for the location and duty.
- provide all plug cocks as purge valves. All plug cocks shall comply with BS 1552.
  Refer also to Section Pipework, Valves & Accessories.

2.20.8 Solenoid Gas Shut-Off Valves

Solenoid operated gas shut off valves shall be provided to automatically isolate the gas supply to the following areas:
(i) Plant Rooms (ii) Boiler Room (iii) Kitchens (iv) Laboratories and Classrooms
Where possible the valves shall be located remote form the areas being protected, provided that the location will not permit unauthorised interference.
Gas shut off valves shall be electrically operated and arranged to provide a positive shut off. Valves for pipes 65mm diameter or larger shall be weight assisted. Valves shall be controlled so that they do not close on power failure. Where operated by the main fire alarm system they shall be controlled so that they do not close when the system is under test.
A gas proving system shall be provided downstream of the valve. Should the gas pressure not be proved, then the valve shall remain closed. An audible and visual alarm shall be given both local to the valve controls and centrally to the main control panel or BMS system.

2.20.9 Electrical Bonding

The pipework installation shall be electrically cross bonded with connections by either a purpose made robust clamp or clip. The work shall be carried out by the Electrical Contractor but the Mechanical Services Contractor shall ensure that all work is complete.

2.20.10 Equipment Connections

All gas consuming equipment shall be provided with isolating valves in close proximity to the equipment and labelled with a mutual tag securely fixed. The labelling shall be used to identify the valve on the gas schematic diagram in the O&M manual and mounted on the wall of the plant room.

2.20.11 Commercial Kitchens and Catering Kitchens (Education Premises)

The mechanical ventilation and gas supply to the kitchen shall be interlocked in accordance with BS 6173 enabling the gas appliances only to be used when the supply and/or extract ventilation systems are operating.
For kitchens where the cookers are not being replaced, the system shall incorporate a means of proving that all gas appliances are shut off before the gas valve opens. For new kitchens or where the gas appliances are being replaced with and fitted with flame failure devices, a supplementary gas proving device is not required.
Gas emergency knock-off push buttons shall be fitted adjacent to each exit mounted above the light switch.

2.20.12 Laundries

Within laundries where gas fired tumble dryers are to be fitted having integral extract ventilation facilities and approved flame failure devices, the gas supply does not need to be interlocked with the house mechanical ventilation system. Also, a gas proving device shall not befitted.
Gas emergency knock-off push buttons shall be fitted adjacent to each exit mounted above the light switch.

2.20.13 Laboratories

A system of gas control shall be provided in laboratories in Education Premises with the control of gas supply under the control of a Lecturer/Teacher with a knock off switch at each door to the room connected to the solenoid valve.
The installation shall be in accordance with IGE/UP/11 Gas Installation for Educational Establishments.

2.20.14 Plant Rooms

Plant rooms containing gas fire appliances shall be provided with an automatic isolation of the gas supply actuated by the thermal detector over each boiler and/or gas fired hot water supply unit.
Provision shall be incorporated at the fire alarm panel to keep the valve engaged during the testing of the fire alarm after which the detection system shall be automatically reinstated after a preset period.
Knock off push buttons shall be provided at each door to the plant room.
The installation shall be provided with a gas proving system to comply with the requirements of HSE and Gas Safe.

2.20.15 Knock-off Buttons on Safety Systems

All knock off buttons shall:

- Be labelled with engraved and filled labels screw fixed above the button.
- The lettering shall be upper case not less than 5mm high, yellow background with black lettering
- Mushroom headed not less than 25mm diameter recessed in a wall box securely fixed in position.
- Approximately 1500mm above floor level (mounted above light switches).
- Be of an approved manufacturer.

2.21 Testing & Commissioning (Natural Gas & LPG)

The methods, procedures, witnessing and recording of results shall also be in accordance with Section Testing and Commissioning. All testing shall be carried out in accordance with the HVCA Guide – Good Practice on Site Pressure Testing of Pipework.

2.21.1 Pre-testing of existing In accordance with current Regulations and Guidelines

The Contractor is to provide documentation showing calculations, the existing system volume, stabilisation and test parameters and gas test pressure and permissible pressure drop allowance. Test existing installation to these parameters.

2.21.2 Existing with alterations In accordance with current Regulations and Guidelines

The Contractor is to undertake modifications of existing installation and re-test allowing for nil leakage from new modifications.

2.21.3 New installations In accordance with current Regulations and Guidelines

The Contractor is to provide documentation showing the installation volume, stabilisation and test periods and air test pressure

2.21.4 Purging and commissioning In accordance with current Regulations and Guidelines

The Contractor is to provide documentation showing purge volumes and time periods. Purging is to be undertaken using correct purge vent apparatus discharging to atmosphere where it will not present an explosive hazard.

2.21.5 Automatic control systems and electrical plant

All electrical and electronic components installed within the gas installation shall be tested and commissioned and set to work and witnessed by the CA prior to handover.
The setting to work and demonstration of systems and plant shall include the following:

1) Gas proving systems and interlocks with ventilation system and gas solenoid valves
2) Boiler interlocks with fire alarm and sprinkler alarm systems
3) Secondary gas meter BMS interface and monitoring

Any additional demonstrating and witnessing by the CA shall be confirmed elsewhere.

2.21.6 Notice of Compliance

The Contractor shall notify the Contract Administrator of the intended dates of testing not less than five working days prior to the test.
The Contractor shall submit a written record of the test including pressures duration of the test pressure, temperature, date and time.
The Contractor shall submit prior to Practical Completion a letter or certificate stating that all work shall be carried out and tested in accordance with the applicable standards and regulations.

2.21.7 Identification and plant labels

Unless stated otherwise elsewhere all pipework shall be painted the British Standard colour and identified in upper case lettering.
Also refer to Section Labelling and Identification and particular requirements.

2.22 Fuel Oil

2.22.1 Introduction

Fuel oil systems shall comprise all necessary pipework, isolating and balancing valves, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings and tender drawings. Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.22.2 Oil storage tanks

Above ground Provide and install in the positions as agreed with the CA, oil storage tank of the number, type and capacity given elsewhere. Oil tanks to be installed in accordance with the current edition of BS799 Part 5 and BS 5410, and amendments. Fire protection requirements/spacing to comply with BS5410 parts 1 & 2.
Oil tanks shall be provided with overfill protection valves.
Oil tank open vents shall on no account be taken up higher than the design pressure of the tank would allow, unless an unloading device is fitted to the vent, to prevent the tank from being pressurised if overfilled. Vents for internally located tanks shall have two branches, with one vented outside, and an internal branch with Metcraft or approved equivalent pressure relief flap discharging in the bund at low level. Height of external vent, and arrangement of pressure relief flap to be selected to allow air venting outside, to ensure any oil overfill discharges into the bund, and to prevent over pressuring oil tank.
Each oil tank shall be fitted with a dial type contents gauge, an overfill warning alarm. Each bund shall be fitted with a bund alarm. The use of sight glass type gauges is prohibited. Oil contents gauges are to be calibrated in litres from empty and shall be provided with a black line indicating the draw-off level of the tank.
The oil tank drain connection shall be fitted with a plugged quarter turn lever ball valve.
No pipe, fitting, valve, tank or other item of equipment containing fuel oil shall be galvanised or plated.
Install tanks in accordance with manufacturers published recommendations, and to provide sufficient access to tank and bund for servicing tank and bund.

2.22.3 Steel Tanks

Tanks shall be constructed, tested, painted and marked fully in accordance with both the current edition BS 799 Part 5 noting all joints shall be welded both internally and externally; and OFTEC standard OFS T200 Steel Oil Storage Tanks and Tank Bunds, Edition 4 & amendments. External tanks shall be of integrally bunded manufacture, complete with internal fill point and ancillary tank equipment, contained within the bund.
Oil tanks are to be rectangular and are to be of Type J or Type K. Oil tanks in compounds open to the weather are to have tented tops.
Oil storage tanks are to be double welded construction of black mild steel plate to the current edition of BS 4360 grade 43A and shall be fitted with internal stays and stiffening welded to the plates. The stays and stiffening shall be of carbon steel sections, arranged so that they do not restrict drainage of oil or access to any part of the tank. All welding shall be to the current edition of BS EN 1011-1&2.
Each oil tank, before being painted, shall be tested hydraulically at the works to the pressures in the Oil Tank Schedule the pressure being raised slowly and maintained for at least 30 minutes for the examination of the tank for leaks and distortion.
Each oil tank shall be fitted with a raised manhole of 460mm internal diameter, having 6mm thick cover. The manhole cover shall be fitted to the manhole flange with studs and nuts, and shall have a liquid and vapour tight joint made with a gasket of oil resistant material.
Each oil tank shall be fitted with a 65mm BSP boss on the top of the tank, having a gunmetal knock off cap, for the dipstick.
Each oil tank shall be fitted with double welded female screwed bosses for all connections.
The oil fill line, burner feed lines, open vent and drain connections are to be of the sizes shown on the drawings.
The Contractor is responsible for checking that sufficient bearers are provided for each oil tank to be filled without buckling. Each bearer being capped with two layers of bituminous damp course felt of at least the same width as the bearer.

2.22.4 Plastic Tanks

Plastic oil storage tanks are to be constructed, tested, painted and marked fully in accordance with OFTEC standard OFS T100 Polyethylene Oil Storage Tanks & amendments. Tanks shall be integrally bunded complete with internal fill point and ancillary tank equipment, contained within the bund. Plastic tanks shall not be used in an area subject to vandalism.

2.22.5 Redundant Tank(s)

Redundant oil storage tank(s) are to be removed, where agreed with The CA. Allow to remove tank(s) contents and transfer to the new tank installation. Allow to degas tank(s), cut up and remove from the site. This operation may only take place at a weekend or holiday period. It must not take place overnight, mid week or while building users are present on site. Particular care must be taken when cutting up the tank(s) especially with regard to the risk of fire or explosion. Also, steps must be taken to ensure that no fumes from the operation enter nearby buildings whatsoever.
Remove all oil waste from site as per section below:

2.22.6 Oil Contaminated Waste
Remove all oil waste from site, and dispose of in accordance with regulations. Oil is controlled waste and must be disposed of in accordance with the Environmental Protection Act 1990, Section 34, "Waste management, the duty of care, a code of practice".

2.22.7 Temporary Tanks
Only where necessary to keep the existing heaters running, install a temporary bunded oil storage tank outside the building and reconnect to existing oil line(s). Allow to fence in the temporary oil tank to protect the area from building occupants and public. Allow to keep the temporary oil tank supplied with fuel for the period that the tank is required for.

2.22.8 Spill Kit

Provide the property or site manager with an OFTEC oil spill kit (large), or approved equivalent.

2.22.9 Bund and Catchments

The bund must provide containment for any loss of oil from the storage tank and associated valves, taps, filters, vent pipes and filling point. It must be constructed using materials that are completely impermeable to the oil stored. Where draw/off pipework passes through the bund the material used for sealing must be resistant to attack by the oil stored. Its method of sealing and connections shall be such that the overall integrity of the bund is not compromised.
The containment volume must be a minimum of 110% of the total storage volume of hydraulically connected tanks. Where tanks are not hydraulically connected, the containment volume must be a minimum of 125% of the total storage volume of the largest tank. Allow adequate free board height to take into account rainfall, fire fighting agents and dynamic factors. Make allowance for tank piers in the bund volume calculation. Provide sufficient room in tank room & bund, to allow access to bund and tank for service and painting.
Masonry or concrete bunds shall be constructed and sealed in accordance with OFTEC recommendations to CIRIA Report 163.

2.22.10 Oil Fill Point

Remote oil fill points shall be housed in a proprietary purpose made weatherproof lockable steel fill point cabinet. Locate in accessible position agreed with the CA, for ease of filling. The cabinet shall house contents gauge and overfill alarms. Oil fill points are to be fitted with lever operated ball type valves with PTFE seat and non return valves and terminated with a gunmetal nipple and cap. An engraved label shall be fixed adjacent to the fill point on the tank stating the grade of the oil stored in the tank. Provide oil fill points with drip tray.

2.22.11 Oil Transfer Pumps

Provide and install adjacent to the oil storage tanks, oil transfer pumps of the duty, type and make as agreed with the CA.

2.22.12 Tank Room Foam Inlets & Ventilation

Provide internal tank rooms with foam inlet in accordance with Fire Brigade requirements, and BS 5306-1 and amendments. Provide adequate tank room ventilation. Cross ventilation to be provided if possible.

2.22.13 Underground Services

Excavations shall be undertaken with due regard to the current Health and Safety requirements to protect work operatives and members of the general public. Open excavations must be safely fenced off from areas used by members of the public. The Contractor is to exercise due diligence at all times whilst excavating.
In areas congested with other services the Contractor must allow for hand digging to expose pipework, cables, and drainage. Mechanical excavation may proceed once the Contractor is satisfied that the area is clear from obstruction.
Where it is safe to do so, existing underground pipework, cables and drainage must be supported and shored up against possible collapse and damage.

The Contractor shall, at no additional cost, repair/replace any pipes, cables, drainage and all associated equipment that may be damaged whilst undertaking the excavation and reinstatement works.
Underground pipework shall be laid to a depth in reinstated materials equivalent to gas pipework.

2.22.14 Existing services

The proposed route of the new supply/supplies may pass within areas that contain gas/water/heating pipework, electrical, telecommunications, I.T. and data cables, storm and foul drainage.
Where record drawings showing existing underground services are included for use by the Contractor they must not assume that the locations shown are exact or that every service is shown. A CAT (cable avoidance tool) must be used to attempt to locate all existing pipework and electrical supplies prior to any excavations. Lifting of drain covers must be carried out to evaluate the depth and direction of drains.

2.22.15 Pipework

All fill and draw-off pipework shall be provided with pressure test points.

2.22.16 Pipework Summary – Below Ground

Below ground pipework should be avoided. Where there is no other option: Standard Non-metallic, have controlled flexibility and be secondarily contained. Pipework in accordance with OFTEC technical requirement TI/134, the pipe shall have the relevant OFCERT Licence.
It shall be of a composite construction consisting of an inner layer of NYLON 12, an intermediate layer of braided NYLON 6 fibre and an outer layer of polyethylene with barrier layer to inhibit permeation of fuel oil through the piping.
The secondary containment jacket shall be extruded over the primary piping and shall be air testable using approved test boot. It shall be separated from the primary pipe by a thin layer of clear “Mylar” with a series of longitudinal stand-off spokes which run the entire length of the containment jacket.
Fittings: NYLON 6,6 or manufactured of UNC 360 brass installed and secured into the end of the pipe by means of a barbed shaft and further secured by means of two stainless steel heavy duty compression band clamps.
The pipework shall be laid to fall so that any leakage into the secondary containment pipe is captured in a water tight access chamber(s).
Access chamber(s) shall be complete with flexible entry boots for SC pipe and a sealed access cover.
Depth Minimum 600mm, maximum 900mm underground marker tape complete with tracer strip must be laid along the whole length 300mm above the pipe.

2.22.17 Pipework Summary - Above Ground

1) Mild Steel Pipework Standard: Heavy quality black mild steel tube to BS 1387 with welded joints and welding fittings to comply with BS 1965.
On no account shall galvanised or plated pipework or fittings be installed to carry fuel oil
Fittings: Screwed joints with threads to BS 21 may be installed in fuel stores and plant rooms with black malleable iron fittings to BS 143.
Screwed joints are to be made using only oil resistant PTFE thread sealing tape to BS 4375
2) Copper Pipework Standard: Light gauge copper tube of Table X to BS 1057 Part 1
Fittings: Copper capillary fittings to EN 1254 Parts 1 and 5.

2.22.18 Installation

Steel fuel oil pipework within buildings and above ground level shall be installed in heavy quality (red band) black mild steel tube to BS 1387.
Steel fuel oil pipework up to 50mm NB to be assembled with screwed joints and threads to BS 21, and black malleable iron fittings to BS 143 & 1256. Screwed joints shall be made using oil resistant PTFE thread sealing tape to BS 7786.
Steel fuel oil pipework of 65mm NB and above shall be assembled with welded joints and welding fittings to BS 1965 After satisfactory pressure testing and setting to work all above ground steel fuel oil pipework shall be wire brushed and have 2 No. coats of red oxide primer applied. Final top coat of Hammerite black or dark green top coat shall be applied.
Copper fuel oil pipework above ground, and within buildings may only be used in well protected locations, and shall be installed in Kutelex or approved equivalent table Y half hard, green plastic coated copper tube to BS EN 1057-R250. Pipework shall be assembled using copper capillary fittings to BS EN 1254 Parts 1 and 5.
Where copper fuel oil pipework needs to be demountable, a capillary union (Yorkshire YP11 or approved equivalent) shall be used.
Where half hard copper tube has to connect to annealed soft copper either a copper capillary joint, or a Type B flared compression joint shall be used (Kuterlite 1870 or approved equivalent). The flanged fitting adapter shall be used in conjunction with the Kuterlite 900 series dezincification resistant range of fittings.

2.22.19 Valves and Ancillary Equipment - Summary

Type	Conn Size mmØ	Description
Ball	Screwed 15 to 50	Light gauge copper tube of Table X to BS 1057 Part 1
Wedge Gate	Screwed 15 to 5	Copper capillary fittings to EN 1254 Parts 1 and 5
Wedge Gate	Flanged 65 to 100	Light gauge copper tube of Table X to BS 1057 Part 1
Parallel plug	15 to 50	Copper capillary fittings to EN 1254 Parts 1 and 5
Parallel plug	Flanged 65 to 200	Light gauge copper tube of Table X to BS 1057 Part 1
Parallel slide gate	Flanged 65 to 300	Copper capillary fittings to EN 1254 Parts 1 and 5.
Strainer	Screwed 15 to 50	Light gauge copper tube of Table X to BS 1057 Part 1
Strainer	Flanged 65 to 300	Copper capillary fittings to EN 1254 Parts 1 and 5

2.22.20 Application

Valves and fittings shall be metric standard to a pressure/temperature rating of PN10 minimum for ferrous valves and PN minimum for copper alloy valves and shall be suitable for the service in which they are installed. OFCERT Certified equipment to be used where available. Refer to Schedules of Equipment and Materials for details of Fuel Oil Valves & Strainers.

2.22.21 Connections to burners

The outlet line from each oil tank to the burners shall be provided and fitted with a quarter turn lever valve and Duplex oil filter suitable for the oil in use together with a capillary or electronic fire valve. Provide each oil fired burner with a 40mm deep stainless steel oil drip tray. Fabricate with folded top edges, and welded corners.

2.22.22 Identification and Plant Labels

Refer to Section Labelling and Identification and particular requirements.

2.22.23 Testing of Oil Installations

Carry out Class II inspection of the installed oil tank/s , pipework and bund/s in accordance with OFTEC technical information sheet TI/120 item 3, to check for compliance with the “Control of Pollution (Oil Storage)(England) Regulations” and The Environmental Agency Publication PPG2. Provide completed relevant OFTEC CD/10, &/or CD/11 commissioning certificate for installations. Mount copy of CD/10 &/or CD/11, and pressure test certificates in plant room.

The pipework shall be pressure tested in accordance with the OFTEC recommendations prior to priming with fuel oil. Pressure test certificates are to be included in the Manual, and a copy shall be mounted in the plant room.

On completion of oil pipework pressure testing, allow to purge oil lines and set burners running. Details of the installation to be included in the manual, and on record drawings.

2.22.24 O&M Manuals & Record Drawings – Additional Requirements

The manual shall include contingency plans for an oil spill, where there is risk of contamination of controlled waters (as per

recommendations by Environment Agency on "Pollution of Controlled waters"). Particularly where leaked oil might enter controlled waters by means of drains from plant rooms, external surfaces, or from other drains; or by virtue of the potential volume of leaked oil that could drain across un-drained areas to an open drain or waterway.

2.23 Fire Protection: Wet sprinkler systems

The Specialist Sub-Contractor shall include for the full detailed design, installation, testing, commissioning, setting to work and demonstration of the complete sprinkler system.
Full detailed design work, drawings and calculations and operation and maintenance manuals etc., shall be provided which are deemed necessary for obtaining approval of the system by the requisite Authorities prior to submitting the same to the Employer for acceptance.
The Contractor shall also be responsible for the testing and confirming of the existing water supply prior to commencing work on site to prove their suitability for sprinkler and hydrant supplies, also for providing the results of the test to the Contract Administrator (CA) or Engineer.

2.23.1 Design and Approvals

The Contractor shall take responsibility for the design of the installation based upon the Architects drawings. The Contractor shall obtain, at the appropriate time, but in any case prior to installation of the works, the approval of all interested parties.
The Contractor shall be responsible for the design of the services, acoustic and vibration provisions, supports, expansion provisions, draining down, guides and anchors, etc., including items inherent in the preparation of installation drawings, builders work drawings, etc., including items not specified in the documents but which are essential to the satisfactory completion of the works.
Written approvals shall be obtained by the Contractor on the design and principles of the system from all interested parties prior to any fabrication or installation work being carried out.

2.23.2 Acceptable Installers

Only firms listed in the current 'List of Approved Products and Services' published by the Loss Prevention Certification Board as LPS 1048 ‘Certificated’ Installers and the current list of 'LPCB Quality Assessed Companies to ISO 9000/BS5750' published by the Loss Prevention Certification Board will be considered as suitable to carry out the design and installation of the works.
‘Registered Supervised’ Installers are not considered suitable and will not be accepted. Only firms on the agreed list shall be used.

2.23.3 Equipment

Only equipment approved by the Loss Prevention Certification Board and entered on the current 'List of Approved Products and Services' shall be installed. Where particular components, such as the ‘Residential’ type sprinklers specified, are proposed these shall be the subject of the specific written approval of all interested parties and shall, if necessary, appear as non compliances in the Certificate of Conformity referred to elsewhere in this document.

2.23.4 Information to be Supplied by the Contractor

The full extent of the information to be provided by the Contractor to the requisite Authorities including the Building Control Officer, Fire Officer, the Contractor and Engineering Design Practice Ltd shall be as detailed in BS EN 12845 and shall also include builders work drawings where necessary.

2.23.5 Following Completion

The Contractor shall, following completion of satisfactory tests witnessed by the CA but forming part of practical completion, provide a certificate indicating that the work has been completed and the necessary tests of the water supplies carried out in accordance with BS EN 12845.

2.23.6 Tender Drawings

Drawings provided are for information only, indicating common service routes which the Contractor shall take into account when carrying out his detailed design and preparing his co-ordinated drawings.
The Contractor shall allow for additional sprinklers in plant rooms and to the underside of ductwork, common congested areas, roof spaces and voids deeper than 800mm. The full design of the system within these and the parameters described below shall be included by the Contractor at the time of tender.

2.23.7 Sprinkler Block Plan

A block plan of the premises including the location of the sprinkler valve chambers, the location of pumps and tank and the area of protection which each valve controls shall be fixed in a suitable position in the valve/pump chamber and at the remote alarm panel so as to be readily visible to firemen or other persons responding to the alarm. The drawing(s) shall be A3 size, laminated and held in frames secured to the wall in a prominent position.

2.23.8 Schematics

A schematic of the sprinkler plant room pipework valves and fittings shall be hung in the plant room complete with a valve schedule and description for weekly pump testing procedures. The drawing shall be A3 size, laminated and held in a frames secured to the wall in a prominent position.

2.23.9 Water supplies - Fundamental Requirements

Water supplies shall be taken in an approved manner from the hydrant mains supply. Where sufficient flow and pressure exists in the towns main to satisfy the sprinkler systems hazard classification and when written approval is provided from the Water Authority, wet sprinkler systems will be directly fed by the towns main. Where the town's mains have sufficient pressure to provide the flow and pressure requirements of the sprinkler system , water mains low pressure alarms shall be provided via low pressure switches installed on the incoming mains within the sprinkler valve chamber.
The sprinkler control zone valves shall be located in a sprinkler control valve chamber where shown on the tender drawings.
The sprinkler system mains will be located and installed based on the routes and pipework arrangement shown on the tender drawings.

2.23.10 Water Recirculation

Systems to be serviced from a storage tank will, without exception, include a means for water recirculation via the storage tank for when the pumps are operated to demonstrate the pump full flow and pressure performance and may be used for the weekly and other periodic testing procedures.
The system shall be designed to automatically operate using the water from the storage tanks to feed the sprinkler heads.
Manual stop valves used for water recirculation shall be monitored.

2.23.11 Pipework and Fittings

Water supply pipework to be connected directly to the Area Water Authorities mains shall be cast iron or equally approved complete with concrete anchor and thrust block when installed underground.
Above ground pipework shall be galvanised heavyweight tube to BS 1387 with galvanized flanged or screwed fittings to BS 143 and/or galvanised mechanical joints with earth bonding continuity clips. Below the sprinkler valve set-up, and/or black heavy weight steel tube to BS 1387 fabricated with welding fittings to BS 1965 galvanised after manufacture, shall be used. If mechanical joints are used, they should only be used as coupling, suitably support with at least end support within 300mm of the mechanical joint. Water supply pipework between the above ground monitored isolating valves and the underside of the sprinkler control valves shall be galvanised heavy weight tube to BS 1387 with galvanised screwed fittings and/or galvanised mechanical joints and/or black medium weight tube to BS 1387 fabricated with welding fittings to BS 1965 galvanised after manufacture. Pipework above the sprinkler control valves forming part of the sprinkler system shall be black medium weight tube to BS 1387 with screwed fittings to BS 143, grooved mechanical joints complete with earth bonding continuity clips and/or fabricated branches painted with a primer coat of red oxide.
Pipework designed and installed to form part of test drain lines and or group control pipework shall be medium weight galvanized pipe. Pipework and fittings forming compressed air lines on drain shall be galvanized. Pipework forming any drencher pipelines shall be medium weight galvanized tube with screwed fitting. Pipework of 50mm diameter and below shall not be welded but may be fabricated off site. Connections to an appliance shall be by flanged, screwed, or mechanical joint as appropriate. The Contractor's attention is drawn to the necessity of providing earth continuity and in particular to mechanical joints where the joint must be installed with the proprietary earthing strap. Flange joints shall be generally to BS 4504.
Hydraulic testing of sections or complete installation shall be to a minimum of 15 bar for tank fed systems and 150% of the maximum mains water standing pressure for systems to be connected directly to the mains water supply. The test pressure shall be maintained for a minimum of 2 hours with no apparent loss in pressure. The pipework system shall be first tested with compressed air to ensure that there are no open ends or split fillings. Following a satisfactory water pressure test, a suitable air test shall be undertaken to prove that the mains are sound and in a suitable condition.
The Contractor shall allow for wire brushing and painting with red oxide primer any of the pipework, fittings or supports etc., where the original primer has been damaged and/or rust has formed.

2.23.12 Pipe Supports

Pipe supports shall conform to BS EN 12845.

2.23.13 Sleeves & Cover Plates

Sleeves and cover plates shall be built in by the Builder after correct positioning by the Installer. Where pipework passes through walls, floors or ceilings, tubular pipe sleeves of a non combustible material compatible with the pipework shall be fitted. The internal diameter of the sleeve shall not exceed the outside diameter of the pipework enclosed by more than 20mm and shall project 3mm beyond the finished surfaces.
Sleeves in a vertical position where washing down of floors is likely to be carried out shall project 40mm above the finished floor level and shall be filled with waterproof mastic. Sleeves shall be constructed of materials which do not contain asbestos and do not give off toxic fumes or smoke. Puddle flanged sleeves shall be provided where sprinkler pipes pass through an external wall or floor below ground level. Puddle flanges of the bolt on type shall be of an agreed pattern. Three layers of protective tape shall be wrapped round the barrel of the pipe before the puddle flange is bolted on, to ensure a watertight joint between the pipe and the flange. The annular space shall be sealed with a flexible compound to ensure a watertight joint between the service pipe and the sleeve.
Where pipework passes through floors, walls, ceilings or false ceilings and is exposed in rooms, other than plant rooms, masking plates shall be fitted. Adequate clearance shall be provided to allow the masking plates to be fitted. Cover plates shall be one of the following.

- High impact polypropylene
- Zinc alloy die cast polished aluminium
- Chrome finish
- Stainless Steel

2.23.14 Stop Valves

Stop valves of all types and drain cocks etc., shall comply with the requirements of the BS EN 12845 being self retained valves and be Water Regulations approved. All wet and alternate alarm valves shall be of a type approved by the LPC and be complete with approved air compressors, condenser bottle, safety valves and air accelerators.
Any valves required by the Water Authority shall be stamped and tested and costs shall be deemed included.
All stop valves shall be right handed and clearly marked to show direction in which the hand wheel is turned to close the valve.
All stop valves isolating valves 80mm and above installed as part of the sprinkler system i.e. installation control valves, and delivery stop valves, zone isolation stop valves, etc. shall be fitted with an approved indicator which shall show whether the valve is open or closed and integral electrically operated limit switches which shall be arranged to give a remote signal should the valve be: a) closed or partially closed, or b) open or partially open in the case of valves whose purpose is to provide recirculation.
Butterfly valves shall be flanged or retained gear operated butterfly valves and only used in the following locations:
a) On and above sprinkler wet dry valve sets
b) On sprinkler valve set test lines
Non return valves conforming to the requirements of the LPC and current Water Regulations shall be provided on the incoming sprinkler fire mains to the building. A pressure gauge and cock for testing the non-return valve shall be fitted between the back pressure valve and the supply control valve.
Note: Test valve arrangement shall be installed above ground.

2.23.15 Sprinkler Test Valve

Provide a test valve adjacent to the highest sprinkler on the installation capable of discharging a flow at a rate of not less than that of the equivalent of one sprinkler head operating.

2.23.16 Drainage

All sprinkler installation valves shall be provided with an approved test and drain facility.
Test drain points shall be taken to the nearest gullies with medium weight galvanised steel supported pipework. Where pipework within the system will not drain back via the installation control valves, drain valves shall be provided at the lowest point and conform to the following:- Up to 50mm diameter pipework:15mm drain valve 65mm and 80mm dia pipework: 25mm drain valve 100mm and above: 32mm drain valve
Additional drain valves shall be installed to ensure complete draining of the system by: i) Installing 20mm BS 1010 fixed jumper stop valves to act as test valves at the furthest points of the system ii) Approved sized stop valves complete with brass plugs to ensure complete draining of the system due to the effect of the differential settlement of the ground floor slab. Details of the potential settlement shall be obtained from the Contractor. Each of the system drain line valves shall be complete with brass plugs. Drain discharges shall be piped into gullies avoiding water to be displaced onto the surrounding floor area.

The contractor shall be responsible for ensuring that the specifying of the correct size and location of drain gullies are included within their scope of work.

2.23.17 Securing of Valves, Labelling & Identification

Secure all stop valves on the incoming supply main connection, pump suctions, pump delivery, pump test and the main stop valve at the installation control valves by leather straps and padlocks. Secure all other valves by leather straps. Provide all valves with engraved labels with the valve number and service engraved thereon, securely fixed in an approved manner. All plant, valves and pipework shall be identified and labelled in accordance with Section Identification and Labelling.

2.23.18 Pressure Gauges

On each sprinkler installation there shall be an oil filled non-loss pressure gauge fitted complete with a plug valve immediately above the alarm valve and another immediately below the alarm and main stop valve.
A pressure gauge as described above shall be fitted on the supply side of the non-return valve on the incoming sprinkler mains.
All pressure gauges shall conform to BS 1780. Pressure gauges shall have scales with divisions not exceeding 0.2 bars.
A means shall be provided to enable pressure gauge to be readily removed without interruption of installation water/air supplies and as described above.
Fit a pressure gauge (gauge 'C') on all sprinkler installations immediately above the alarm valve and another gauge (gauge 'B') immediately below the alarm and main stop valve. Fit a pressure gauge on the supply side of the non-return valve on the incoming supply main (gauge 'A'). Provide means to enable each pressure gauge to be readily removed without interruption of installation water supplies.

2.23.19 Flow Measuring Device (direct reading flow meter)

A flow measuring device of the type approved and listed by LPC shall be provided on the installation control valves, for proving the incoming town mains connections for direct fed systems or pumped circulation for tank fed systems.
The test arrangement shall be installed in medium weight galvanized tube and fitting, then control by two number gear operated valves.
The discharge from the installation control valves and the direct reading flow meter test pipe shall discharge into a break tank (galvanised) of sufficient size to hold the discharge from the test and waste for systems without water storage.
For systems to be served from water storage tanks, the discharge pipework shall be arranged to re- circulate the water flow via the storage tank(s).
For systems served directly from mains water, the discharge from the condense bottle shall be at low level in the sprinkler valve chamber. The compressed air condenser bottle shall be complete with two suitably sized and approved valves. One positioned on the galvanized pipework to the bottle, and one on the outlet to the bottle. This valve shall be complete with a brass plug.

2.23.20 Sprinkler Heads

All sprinkler heads shall be quick response type in accordance with the suitable application as selected from the LPC Technical Bulletin TB207. All sprinkler head types and colour finishes to be agreed with the Architects.

2.23.21 Sprinkler Pumps

The water supplies for the sprinkler protection shall comprise duplicate fire pumps drawing from a water storage tank. The duty of the main pumps shall be based upon standard pre-calculated pipe sizing for the declared system classification as given elsewhere. Sprinkler pumps shall be either electric or electric and diesel driven, whichever is confirmed elsewhere. The system pressure shall be maintained by a “jockey pump” which shall automatically start and stop to maintain the system pressure. This pump shall be installed between the main duty and standby pumps whilst retaining adequate access to the pumps and other plant.

2.23.22 Water Storage Tanks

Water storage tanks shall be GRP or galvanised steel sectional LPCB approved and shall provide the correct capacity according to the specified system classification.
All works associated with an acceptable installation of the tanks shall be the responsibility of the Contractor.
The Contractor shall arrange for the infill main from the Local Authority network to be run to a point close to the base of the cold water tank. The Contractor shall run the infill pipe to the ball valve from this point.

2.23.23 Alarms - Mains Water Alarm Protection

Systems specified to be fed from the Water Authority main supply shall be designed with adequate space in the valve chamber or other designated area, to enable the mains water fed system to be adapted with pumps during the life of the building. An

allowance for storage tank(s) shall not be included within the scope of the building design.
The Contractor shall make space allowance for the installation of an approved false alarm prevention system should local supply mains pressure surges prove to be a problem. This space shall allow for the installation of a jockey pump, control panel, non-return valves etc. to provide a complete installation with necessary interface with the fire alarm installation and remote indication in the sprinkler panels. Suitable pipe connection tappings shall be provided in the sprinkler valve chamber to allow the potential installation with minimum disruption.

2.23.24 Sprinkler Alarm & Indicating Panels

Sprinkler alarm and indicator panels shall be provided where shown on the tender drawings and indicate pumps running and failure and valve monitoring fault. Zone flow switch operation shall be relayed to the fire alarm panel to give a fire alarm. The alarm panels shall be suitable for recessed mounting alongside the buildings' fire alarm panel local to the main entrance. The Contractor shall ensure that the works electrical cabling is installed in an approved manner with alarm panel wiring diagrams. The fire alarm cabling is to be fire survival cable conforming to BS 6387.

2.23.25 Water Turbine Alarm and Gong

The sprinkler installation shall be provided with a water turbine alarm, fire valve, and gong of the type approved and listed by the LPC committee. The valve set shall be complete with a full sized by-pass so that the valves can be maintained without interrupting the supply to the systems. The fire valve shall be located adjacent to the sprinkler pumps and the gong shall be located not higher than 3m above the ground level immediately external from the pump room.
A 15mm test valve shall be provided on the installation side of the alarm for the purpose of testing the alarm gong.
The pipework to the fire valve shall be arranged to drain through a fitting having an orifice not larger than 3mm diameter. The orifice plate shall be either of stainless steel or a suitable non ferrous material. This shall drain into an open tundish. The water motor test and drain line shall be installed in medium weight galvanized pipework and fittings, installed to discharge over the sprinkler drain and test bund positioned within the sprinkler valve chamber.

2.23.26 Sprinkler Installation Control Valves

One set of 'Wet' 'Life Safety' sprinkler installation control valves shall be fitted in the pump room. The valve set shall be complete with a full sized by-pass so that the valves can be maintained without interrupting the supply to the systems and shall comprise at least the following:

- All system isolating Stop Valve, electrically monitored to indicate when the valve is not fully open (or closed in the case of the by-pass).
- LPC approved 'Wet' Alarm Valve
- Alarm Gong and Water Turbine for sounding an audible warning of system operation
- Pressure switch mounted in alarm gong pipework for initiation of an electrical signal on system operation
- Drain and Test connection
- 15mm Test Valve, Pipeline and fittings

All necessary small bore pipework (galvanised), pressure gauges and valves shall be provided in accordance with the requirement of the LPC Rules and Approvals. Substantial brackets shall be provided to support and restrain the valve set and manifold. Full flow testing facilities shall be provided in the pump house for the testing of the pumps and this shall include a pipe to return water to the storage tank. All the above to be complete with pipework, valves, straps, padlocks and identification labels.

2.23.27 Electrical Work

Electrical works carried out as part of the sprinkler contract shall be undertaken by the Contractor under the same terms and conditions as the Electrical Sub-contract, in accordance with Section Automatic Controls, Plant Wiring & Switchgear. Electrical works shall only be carried out by competent persons employed by an electrical contracting firm which is a member of Electrical Contracting Association (ECA) and National Inspection Council for Electrical Contracting (NICEC). The electrical works shall comprise the wiring to the pumps, remote alarm panel and trace heating installations that are described elsewhere. The work shall commence at an isolator provided by others, which shall be located adjacent to the control panel. The Contractor shall confirm the power rating of the isolator and the power supply requirements in accordance with the construction programme. The Contractor shall be responsible for the design and installation of wiring and containment to the pumps from the control panel. Two independent power supplies shall be installed to the sprinkler pump room where both sprinkler pumps are designed to be electrically. The Contractor shall be responsible for supplying, installing and wiring the control panels, sprinkler pumps and controls. The Contractor shall be responsible for all other electrical equipment and ancillaries wired from a local power isolator(s) supplied from local distribution boards.

2.23.28 Control Panel

Sprinkler pump control panels shall be provided and fitted in the sprinkler pump room. The Contractor shall be responsible for

linking the sprinkler control panel to the site fire alarm system and all other wiring from the control panel to the electrically operated plant as supplied, and between the monitored isolating and control valves to the sprinkler monitoring panel and all other wiring requirements within the scope of the sprinkler installation.
Control panels shall be wall mounted and a minimum clear working space in front of not less than 1.00m shall be maintained. Control panels shall be clearly labelled to match the numbering of the pumps.

2.23.29 Remote Alarms

The Contractor shall install water flow alarm switches, stop valve/butterfly valve limit switches, pressure switches onto the sprinkler system as required. These alarms shall give a central indication to the sprinkler system monitoring panel located adjacent to the fire alarm panel. Note: This LPC approved sprinkler monitoring panel shall be provided and fixed by the Contractor as part of the contract works. This is in addition to the main sprinkler control panel(s) required to be supplied and installed in the sprinkler valve chamber or pump house.

2.23.30 Zone Alarms

Each area of protection shall be fed through a zone valve arrangement comprising monitored isolating valve, drain/test pipework and water flow alarm switch in a similar style to that of a life safety installation. Provide each sprinkler installation with an approved pressure switch at the installation control valves.

2.23.31 Monitoring

The condition of the pumps and all main and zone stop valves and shall be monitored at the sprinkler pump monitoring panel to be mounted alongside the fire alarm panel in the main entrance lobby.

2.23.32 Systems Liable to Freeze

The Contractor shall allow for supplying and fitting a wall mounted thermostatically controlled electric heater in the pump house. The heater shall be suitable for maintaining a room temperature of 5°C for electrically driven pump houses and 10°C for diesel driven pump houses, when the outside ambient may fall to –10°C. External pipework shall be insulted with protective finish in accordance with Section Insulation material/covering and Pipework insulation: Chilled and cold water services. External pipework shall also be trace heated in accordance with Section Freeze protection to exposed mechanical services. Power supplies to un-switched fused connection units shall be supplied and installed by the Electrical Installation Contractor from the local power distribution board. The Sprinkler Installation Contractor shall wire the heater and trace heating from these fused connections units and shall include for testing, commissioning and setting to work.

2.23.33 Testing

The Contractor shall include for hydraulic testing and flushing to be carried out as and when necessary during the progress of the works. He shall be required to test the installation in sections as appropriate and he shall allow sufficient time in the works programme for whatever adjustments and modifications are necessary following each sectional test.
The Contractor shall carry out a low pressure air test, to establish whether open ends are present, prior to carrying out an hydraulic test on completion of the installation, or sections thereof. The hydraulic test pressure shall be 1.5 times normal working pressure or 15 bar, which ever is the greater, and shall be for a period of two hours without significant loss of pressure. The gauge used to demonstrate the test shall be 150mm dial 0-20 bar with maximum calibrations of 0.5 bar and a valid calibration certificate shall be provided. No programme delay will be permitted for any test failures or the time for re-testing to be carried out.
Test certificates shall be issued after each test and these must be signed by the Purchaser or his representative. Copies of these certificates shall be included in the operating and maintenance manual.

2.23.34 Pre-Handover System Flow Demonstration

The Contractor shall demonstrate to the CA that the installed pumps meet the specified flow rates against the corresponding developed pump head pressures in accordance with Table 16 of BS 12845 for the appropriate hazard classification.
Systems shall not be accepted as complete until the demonstration(s) confirms compliance with these requirements.

2.23.35 Practical Completion

2.23.36 Completion Upon completion of the installation of the system, tests to demonstrate the satisfactory operation of the system are to be carried out in the presence of all interested parties to prove to the satisfaction of all present that the installation conforms to the required standards.
When these tests have been accepted by all parties as being satisfactory a completion certificate as defined in Section 10 of the LPC Rules shall be issued.

In addition to the Completion Certificate an LPCB Certificate of Conformity shall be issued by the Contractor as required in LPS1048 and the installation shall be registered as a Certified Sprinkler System.

2.23.37 Certificates & documentation

The Contractor shall, following completion of satisfactory tests witnessed by the CA, provide a certificate indicating that the work has been completed and the necessary tests of the water supplies carried out in accordance with BS EN 12845.

Practical Completion shall not be granted if the final and approved O&M Manuals and Record Drawings and documentation has not been submitted.

2.23.38 Maintenance & servicing under the warranty period The Contractor shall note that he will be responsible for carrying out the weekly tests for the full 12 months warranty period.

2.24 Pipework, Valves & Accessories - Hydraulic Systems

2.24.1 Introduction

Pipework, valves and accessories used to form part of completed systems shall be in accordance with the construction and manufacturers drawings and shall comply with the specification, Appendices and tender drawings.
Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator before the issue of the Practical Completion Certificate.

2.24.2 Pipework Requirements

Pipework shall be free from surface or general corrosion, deleterious film and without scaling, pitting, excess weathering or damage. Bores shall be clean and unobstructed. Pipework so affected shall be removed from site and replaced.
Pipework shall be cut, where necessary, to leave the tube bore unobstructed and without deformation. Copper tubes shall be cut with a tube cutter and reamed out to full bore at the cut end. Unless otherwise specified, all pipe sizes listed are nominal internal dimensions.

2.24.3 Pipework Storage

Care should be exercised whilst off-loading, storing, transporting about the site, and whilst installing pipework and fittings to ensure that no accidental damage occurs to the pipework or fittings. Plastic pipework and fittings shall not be stored where they may be exposed to the effects of ultra violet radiation including daylight Pipes shall be stored clear of the ground on flat and level surfaces or on packing. The area shall be free from protrusions likely to damage the pipes. Pipework stored externally shall be adequately covered to protect it from the weather.

2.24.4 Pressure Testing of Pipework

Refer to “Hydraulic tests” in Section Testing and Commissioning

2.24.5 Pipework Installation

All visible supports shall be of neat appearance and subject to approval by the Engineer. All pipe sets shall be free from flattening, tool marks or distortion and any not conforming to these requirements shall be replaced at Contractor’s expense. When sets are made in steel piping heavy quality tube must be employed.
No product containing lead or lead alloy shall be used in the Works, except where necessary on drainage or rainwater pipework. Any work using such products will be condemned.
Joints shall not be made in the thickness of any wall, floor or ceiling and pipework shall not be embedded in brickwork or concrete unless specially agreed.

Formed bends and sets or cast ductile iron elbows shall, wherever practicable, be used in preference to fabricated fittings. Bends and sets in pipework shall be cold drawn by a hydraulic bending machine for sizes up to 50mm bore, with larger sizes fire made. The radius shall be not less than three times the pipe diameter. Bends and sets shall be made without deformation. Curved or long sweep bends and branches shall be used as far as is practicable. Where air pipes, air bottles, drain or dirt pockets or air venting requirements dictate, square connections and fittings shall be used.

All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
Fittings shall be of the same size as the pipe in which they are installed. Bushing down will not be accepted. Changes in diameter in pipe runs shall be made with eccentric reducers in horizontal pipe runs and concentric in vertical pipe runs to allow free draining and venting of the connected systems.

Unions or flanged joints shall be installed at a maximum spacing of 12 metres on pipe runs, at plant items and on the dead side of all isolation, regulating and commissioning valves to permit dismantling. They shall also be provided to allow control valves, strainers and the like to be removed for maintenance purposes.

Unions or flanged joints for servicing are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.) The distance between any two branches shall not be less than the sum of their outside diameters. The layout of fittings at branch connections or other fixed points of the system shall allow provision for movement without causing undue stress to the pipework.
Pipework shall be arranged to reduce the strain on plant and equipment due to expansion. For water systems, use adequate numbers of Victaulic grooved joint flexible couplings in header piping to allow provision for movement.

Pipework, fittings, support steelwork and brackets shall be thoroughly cleaned immediately on completion. One coat of zinc based primer shall then be applied to all ferrous pipework, fittings, support steelwork and brackets prior to insulation being applied. Before any existing main is cut, it shall be checked to ensure that it is isolated and drained as far as is possible or that the internal pressure has been released. The Mechanical Services Installer shall ensure that the correct pipe is being cut into and the pipe is dead.

2.24.6 Pipe Ends Preparation and Cutting

Pipework shall be cut clean and square with it's axis, by machine, pipe cutter or saw as appropriate to the pipe material. Flame cutting and bevel wheel cutters are not permitted. All cut pipe ends shall be well and truly reamed and burrs removed to ensure that the full pipe bore is available before jointing. Screwed threads shall be reamed, de-burred and all oil and swarf removed. Exposed threads shall painted immediately the joint has been made. Grooved ends shall be free from indentations or projections in the area from pipe end to groove.

2.24.7 Thread Sealants

Thread sealants for hot and cold water services shall be approved by the Water Research Centre as suitable for potable water and proof against bacterial growth. Thread sealants for natural gas services shall be as approved by British Gas Publications IM/16, and shall be wound on spools marked "Satisfies BGC/IM/16".

2.24.8 Unions, Flanges & Gaskets

Unions shall be limited to 50mm pipework or below and shall be assembled without the use of paste or lubricants when used on hot and cold water services. Flanges shall be used on 65mm pipework and above, and on smaller pipes when specified. Unions or flanged joints for servicing are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.) Gaskets shall be free from asbestos materials and shall be assembled without the use of paste or lubricants when used on hot and cold water services. They shall be provided with non-stick surfaces where flanged joints are required to be easily opened.

2.24.9 Pipe Runs, Gradients and Break Points

All pipes shall follow the lines of walls in the vertical run, as indicated on drawings unless the site conditions prevent this, in which case the runs may be varied to suit the site conditions subject to the agreement of the Contract Administrator (CA). Pipework in the vertical run, shall be set plumb and without offset.
Pipework in the horizontal run shall follow the contours of the building, and be graded for venting and draining, shall be formed around all projections and recesses and shall be offset as required due to varying thicknesses of walls, floors, ceilings and other structural works or services, whether such changes in direction are indicated on the drawings or not. Pipe runs shall be arranged with adequate clearance to provide easy access to all items of the service including valves, unions and flanges. Joints in walls, floors and structure in general will not be allowed. All pipework services shall be graded to rise or fall in the direction of flow, at 1:250, except for gravity condensate and drainage from air handling units which shall be graded at 1:100. Pipework services shall be provided with break points with unions and/or flanges at the following positions:

- At every branch from headers, mains and risers.
- At all connections to plant and equipment.
- At 18m intervals for unions.
- At 10m intervals for flanges.
- Stop valves within 300mm of every sanitary appliance.
- Not required on installations using grooved joint couplings.

2.24.10 Open Ends

Open ends left during the progress of the work shall be blanked off with purpose made metal or plastic plugs, caps or blank counter-flanges. Closed valves, sticky tape, wood, paper, cloth or other similar materials will not be permitted. Where open or improperly blanked ends are left, the CA may require that the pipework is disconnected for inspection. Such disconnection shall be taken sufficiently far back and be carried out in such sections as to determine that the bores have not been obstructed by foreign matter. The Contractor shall be responsible for locating and removing any stoppage (foreign matter or air) found to exist on completion of the work. This shall include cost of all replacement by him and of all making good or redecoration by the Main Contractor.

2.24.11 Supports

Supports shall be designed by the Mechanical Services Installer to adequately support the pipework, insulation and contents without deformation of the pipework. The supports shall be designed to allow free movement for expansion and contraction. Each pipe shall be independently supported from other pipework. Details of all supports shall be submitted to the CA for comment prior to manufacture. Supports shall be positioned adjacent to all valves and other in-line components to ensure that undue strain is not imposed on the adjoining pipework and so that the component may be removed.
Where services are installed in riser ducts or trenches and where suitably grouped in false ceilings a unitary bracketing system shall be used. External ferrous metal supports shall be hot dip galvanised after fabrication. Where such supports are used for non-ferrous pipework an inert liner shall be interposed.
Supports for insulated chilled water pipework shall be provided with treated hardwood block spacers of the same thickness as the insulation and extending a minimum of 25mm clear either side of the support.
Vertical pipework shall be supported on load bearing brackets at slab level to withstand the total weight of the riser. Intermediate supports shall be fixed to the walls at the intervals previously described. Branches from the riser shall not be used as a means of support.
Supports shall be secured to slabs by fixings agreed with the Structural Engineer. Fixings shall be installed in accordance with the manufacturers recommendations. Drilled fixings to trough floors shall be to the sides of the ribs, not the soffit. Shot fired fixings shall not be used or any reinforcement drilled through.
Cast iron or mild steel pipe supports shall be malleable iron or mild steel. Brackets for copper tube shall be brass, gunmetal, or mild steel with an inert liner. Supports shall be of the two piece pattern where one half of the clip shall be detachable without disturbing the fixing. On insulated pipework the bolts securing the two parts shall be clear of the insulation. Saddle strap and plastic pipe supports shall not be accepted for metal pipework.
Pipework in exposed positions shall be supported using split ring brackets screwed or plugged to the walls. Mild steel pipe brackets shall be malleable iron with black enamel or galvanized finish to match the pipe. Copper pipework brackets shall be cast brass or gunmetal.
Where exposed pipework is specified as being chromium plated, the support brackets shall be similarly chromium plated.
All pipe near floors which are liable to be stood on by occupants, shall be supported off the floor with split ring clips.

2.24.12 Support Spacing

The spacing of pipework supports shall not exceed the centres given in the tables below. Where two or more pipes are supported on one fixing, the support centres shall be based upon the requirements of the smallest diameter pipe.

2.24.13 Spacing of Pipework Services, Clearances & Segregation

Pipework shall be installed to give the following minimum clearances between the pipe, or pipe insulation where appropriate, and adjacent surfaces. Refer to Schedules of Equipment & Materials. Notwithstanding the above minimum clearances sufficient space shall be allowed to permit easy application of insulating materials and permit easy maintenance access for appliances
Pipes shall not be enclosed in a common covering.
Spacing of gas and water services below ground shall comply with the requirement of British Gas and the Local Water Authority.
Horizontal hot water pipework shall always be located above cold water pipework to minimize heat transfer.

2.24.14 Sleeves & Cover Plates

Sleeves and cover plates shall be built in by the Builder after correct positioning by the Installer.
Where pipework passes through walls, floors or ceilings, tubular pipe sleeves of a non combustible material compatible with the pipework shall be fitted. The internal diameter of the sleeve shall, except where necessary to allow for expansion and contraction, not exceed the outside diameter of the pipework enclosed by more than 20mm and shall project 3mm beyond the finished surfaces. Sleeves in a vertical position where washing down of floors is likely to be carried out shall project 40mm above the finished floor level and shall be filled with waterproof mastic. Sleeves on pipework with a normal operating temperature below 15°C including domestic water services shall be oversized to allow for the thermal insulation to be taken through the sleeve. Provision shall also be made in such cases to allow for continuity of the vapour seal. Where pipes pass through a fire barrier they shall be provided with a fire stop complying with the Fire Officers requirements.
On insulated pipework the unit shall provide the same thickness of insulation as used either side of the barrier. The insulation and any vapour barrier shall be continuous. For bare pipework the fire stop shall have sufficient thickness of insulation to accommodate movement due to expansion. Alternatively, on bare pipework, purpose made fire sleeves may be fitted. Purpose made fire sleeves shall comprise a one piece mild steel plated sheet with closure tabs and slots allowing it to be wrapped round the pipe. Each end of the sleeve shall be provided with an intumescent foam having a minimum thickness of 10mm. Sleeves shall be the correct length to fit the structure and shall be securely grouted in. Sleeves shall be constructed of materials which do not contain asbestos and do not give off toxic fumes or smoke.
Puddle flanged sleeves shall be provided for incoming services where they pass through the external wall below ground level. Puddle flanges of the bolt on type shall be of an agreed pattern. Three layers of protective tape shall be wrapped round the barrel

of the pipe before the puddle flange is bolted on, to ensure a watertight joint between the pipe and the flange. The annular space shall be sealed with a flexible compound to ensure a watertight joint between the service pipe and the sleeve.
Where un-insulated pipework, exposed in rooms, other than plant rooms, pass through floors, walls, ceilings or false ceilings, masking plates shall be fitted. Adequate clearance shall be provided to allow the masking plates to be fitted. Cover plates shall be one of the following:

- High impact polypropylene
- Zinc alloy die cast polished aluminium
- Chrome finish
- Stainless Steel

2.24.15 Fittings

All fittings in pipework carrying water in circulation are to be low resistance of the sweep or pitcher type, with the exception of square tees installed for draw-off draining or air venting purposes.
Eccentric fittings in the horizontal run, at changes of diameter shall have the taper of the fitting rise in the direction of flow to facilitate venting and draining.
Screwed fittings for mild steel pipe shall be malleable cast iron with screwed threads, tapered external and parallel internal threads. Where used on galvanised pipework screwed fittings shall be galvanised.
Welding fittings shall be of the forged seamless pattern, manufactured from carbon steel. Grooved fittings shall be wrought steel, cast ductile iron, or factory-fabricated steel, as specified elsewhere.
All unions shall have metal to metal conical ground seats – it is emphasised that long screw connectors will not be accepted anywhere.
Malleable iron elbows shall not be employed. Pipe sockets on malleable M and F bends will not be accepted, bends shall be male or female ends as required. Any reduction in the bore of circulating pipework shall be made by means of eccentric reducing sockets where it is necessary to maintain a constant rise in the direction of flow to permit the free venting of air. Reducing fittings may be used where this condition does not arise but in no circumstances may bushes be used to effect a reduction of bore.

2.24.16 Venting, Draining & Dirt Collection

No open vent pipework is to be run from heating and hot water services installations other than open safety vents specified for boilers to prevent priming or inducing air into the system. Air bottles, manual or automatic air vents shall be installed on all high points in the pipework system to facilitate venting of the system as required.
Automatic Air Vents shall be fitted with an isolation valve to allow removal of the vent without draining the system.
Each automatic air vent shall have discharge pipes of half hard annealed copper tube. The discharge pipes are to be run so that any water discharging will be easily seen, and the pipe shall preferably be terminated to discharge outside the building or into a gully or sink. Air vents and release pipes shall be installed in such a manner as to prevent freezing.
Air bottles shall be manufactured from 150mm lengths of pipe of the same diameter and material as the pipe to be vented, provided the air bottle is of not less than 32mm. Where air bottles are in accessible positions the air cocks may be fitted directly on to them. Where air bottles are installed in positions inaccessible to the staff of the building, a 10mm steel pipe is to be run from the top of the air bottle to terminate with a needle valve in an accessible position not more than 1.6 metres from floor level. Where possible needle valve terminations shall be grouped for convenient access. Each termination shall be provided with a label identifying the service to which the termination applies. On low or medium temperature pipework the air release pipe shall be fitted with a 6mm needle seated key operated cock. On high temperature pipework it shall be fitted with a 10mm needle seated globe valve arranged for key operation and fitted with a sunken plug.
For high temperature pipe work, the bottles shall be 300mm lengths of 50mm bore tube for pipework up to and including 75mm and 400mm lengths of 100mm bore tube for pipework above 75mm. They shall be of welded construction.
Alternatively, for mains of 65mm bore and over, an air bottle of equal bore to the pipe and at least 300mm long, shall be welded to the pipe forming a pocket. The pocket shall be finished as described above.
Tops of risers shall be continued as full bore air bottles for a minimum of 150mm. They shall be constructed as described above. Each such air bottle shall be provided with a manual air vent with a minimum size of 25mm for use in connection with system flushing.

2.24.17 Drain Points and Dirt Pockets

Drain cocks are to be fitted in pipework at all low points to enable the whole of the pipework to be drained of water. They shall also be provided to allow plant, equipment and connections to sanitary fittings to be drained.
Drain cocks are to be fitted in pipework on the dead side of valved branches pipework to facilitate maintenance of the branch.
Drain cocks on systems containing glycol shall be labelled to prevent draining direct to mains drainage.
On low or medium pressure systems drain cocks shall comprise standard hose union gland type drain cocks with detachable keys manufactured from cast gunmetal or bronze. On high pressure hot water systems they shall comprise a needle seated key operated globe valve. On open circuit systems they shall be screw down pattern.
Drain and drip points at pumps, cooler coils, safety valves, safety cocks and other equipment shall be provided with drain lines

discharging into tundishes adjacent to the equipment. Where necessary to prevent back suction, drains from equipment shall be fitted with cleanable traps of a depth such that the water seal is not broken by the system pressure.
Tundishes shall be sized for the expected discharge and shall be constructed from copper or stainless steel sheet. A rolled top rim shall be formed to stiffen the tundish and a hinged lid provided to allow for examination of the drip pipes without disturbing the drain lines.
Tundishes shall discharge into copper pipes run to convenient floor gullies or sumps.
Scale or dirt pockets shall be provided on the return to any boiler, calorifier, air heater or other similar plant or equipment, at a low point adjacent to the plant or equipment. Pockets shall be of the same size as the pipe, not less than 150mm deep. Pockets shall be fitted with a welded flange and bolted blank companion flange arranged to allow easy removal for cleaning. Alternatively, on low and medium temperature systems, pockets of 50mm bore or smaller may be fitted with screwed plugs or caps.
On closed circuit systems blow down pockets of the same diameter as the pipe shall be provided at the base of main risers, at low points in plant rooms and at the end of long horizontal runs to allow removal of sludge. They shall be constructed in the same manner as the scale or dirt pockets described above. Each pocket shall be provided with a quarter turn ball valve with a detachable lever and hose connection for drainage. Valves shall be line size up to 40 mm diameter pipework and 50mm diameter for larger pipework. Drain valves shall be fitted with sufficient clearance to permit attachment of a drain hose.

2.24.18 AAVs, Dirt & Air Separators

All heating and chilled water systems shall be fitted with purpose designed air and dirt separators. The units may be designed and manufactured for the individual tasks or combined to take care of air elimination and dirt separation, providing the pipework is designed accordingly. Air separators, or deaerators, shall be designed for trapping and releasing micro air bubbles automatically for the heating or chilled water systems. they shall be mounted in the hottest part of the system respectively (i.e. in the flow header leaving the boiler(s) or in the chilled water return to the chiller(s). Air separators shall be fitted with an integral strainer which does not have an effect upon the system pressure loss when collecting dirt. Air and dirt separators shall have the facility of removing the dirt without shutting down the system it serves. All units shall be of one manufacturer selected form the Spirovent range by Spirotech Ltd or the Stourflex range of products by J&P Supplies Ltd.

2.24.19 Concealed Pipework

All heating pipes in ducts shall be welded and supported on rollers and chairs attached to steel channel, inserted in duct wall. Pipes shall be suitably arranged and supported to allow for expansion and contraction.
On no account shall ducts carrying pipes containing water be filled with sand, concrete, vermiculite, or any other material. Such ducts must be of open construction, having inspection covers at changes of direction. The Contractor is to ensure that this is adhered.

2.24.20 Access Ducts for Pipework

Pipework enclosures, ducts and casings shall be provided with ready access for maintenance, testing and clearing. Access for clearing shall be carefully sited in conjunction with other services to allow the entry of clearing apparatus. Valves and access points shall be positioned such that duct openings may be in a suitable position and the number kept to a minimum.
When all services have been completed and tested, ducts shall, unless otherwise described, be sealed at each floor by concrete poured to the same thickness and in the same position as the building floor slabs. Pipes passing through slabs shall be provided with sleeves. The concrete sealing shall be carried out to ensure that the concrete work is properly completed without disturbance or damage to the pipework.

2.24.21 Electrolytic Action

Electrolytic action shall be prevented by ensuring that dissimilar metals are not in contact where the presence of water or moisture could promote electrolytic action. Where copper pipework connects to ferrous equipment or cisterns, whether galvanised or not, approved fibre washers or gaskets shall be used for the connections. The Contractor shall not connect copper pipework to steel pipework without the agreement of the CA in writing.
Supports shall be galvanised malleable iron or steel for steel and iron pipes, brass or gun metal for copper, stainless steel or plastic pipework.

2.24.22 Equipment By-Passes

Each piece of plant or terminal equipment which is provided with controls or is of such construction as to be subject to blockage during cleaning and flushing operations shall be provided with a permanent by-pass. By-passes shall be fitted across the flow and return connection of the equipment on the live side of the equipment valves. By-passes shall be pipeline size and fitted with a full bore, quarter turn ball valve, operated by a detachable lever.

2.24.23 Expansion loops & bellows

As far as practicable expansion shall be accommodated by changes of direction in pipes runs, but where necessary, expansion bellows are to be installed.

Setting out of pipework shall take into account natural flexibility. Attention shall be given to the detailed arrangement of supports, branch connections and restraints imposed by structure or other services. Where the natural flexibility of the pipework is insufficient, the expansion shall be taken up with expansion bellows, joints, compensators or loops.

Pipework shall be anchored and guided in accordance with the manufacturer's recommendations. Expansion loops or bends shall be one piece and made at the tube or fitting manufacturer's works. If the total length of tube in the loop or bend is such as to prohibit this, welds may be made in the long arms as near the centre as possible. No welds will be permitted in the crown of the bend or in the short arms and any seams shall be arranged at the side of the bends. Loops or bends shall be flanged and arranged to vent and drain naturally.

Expansion loops, bends or joints shall be erected with cold draw to half the total calculated expansion to be absorbed by the loop. Care shall be taken to ensure that all cold draw allowances are observed and that no slip occurs at the anchors.

Where bends and loops are not a practicable solution, provision for expansion shall be by the insertion of stainless steel expansion bellows, flanged or screwed as required. Expansion bellows shall be located and installed to the requirements of the bellows manufacturer. For water systems using grooved pipework fittings and accessories, use adequate numbers of Victaulic flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops, in accordance with manufacturer's instructions. Where expansion loops are required, use Victaulic flexible couplings within the loops.

Expansion bellows installed in black or galvanised mild steel tube systems are to be of stainless steel and expansion bellows installed in copper tube systems shall be of copper.

Articulated type joints incorporating two bellows are to be used where there is likely to be an angular movement.

Expansion shall not be accommodated by allowing screwed joints to swivel with consequent tendency for leakage to occur.

Grooved-end expansion joints shall be Victaulic Series 150 steel pipe fitting comprising telescoping body and slip-pipe sections, PTFE modified polyphenylene sulphide coated slide section, suitable for axial end movement to 3" or Series 155 expansion joint consisting of a series of grooved end pipe nipples joined in tandem with Victaulic Style flexible couplings. Total joint movement dependent on the number of couplings and nipples used.

2.24.24 Anchors & Guides

Wherever necessary to control the direction and extent of expansion movements, the Contractor shall provide sound and secure anchors. Anchors shall be provided for pipework, subject to thermal stress and movement. They shall be of adequate strength to resist the maximum stresses imposed by expansion and contraction of the system. Anchors shall be welded to the pipework. Cleats, brackets and steelwork required for anchor points shall be provided and fixed ready for building in. The proposed method of anchorage shall be submitted to the CA for comment together with corresponding calculations and details of thrust loadings.

Anchors shall not be positioned closer than 600mm to welded joints or connections and shall not deform the pipework in any way. Where necessary, to prevent long pipe runs from buckling and to ensure alignment of pipes and free movement on joints, pipe guides shall be provided. They shall be constructed to prevent radial motion and carefully installed so that axial movements are not hampered.

Axial movement shall be assisted by rollers and chairs. All sleeves and guides shall allow the pipes to pass through with perfect freedom. The weight of pipes shall not be borne by the sleeves or guides. Contractor will be held responsible for ensuring that none of the pipes are bedded in any point as a result of any making good carried out by the Main Contractor or other party. Pipe supports and hangers etc, shall be of design such as will allow free movement of the pipes, having swivel joints or rollers as may be necessary. Guides shall be incorporated at all roller and chair and expansion device locations. Details of anchors and guides shall be submitted to the CA for comment.

2.24.25 Control System Sensors

Where shown on the drawings, the Contractor shall supply and install;

- Stainless steel pockets for temperature sensors.
- Valved sockets for in-line pressure monitoring.

2.24.26 Painting

Upon receipt of pipework deliveries, all steel pipework shall be treated with one coat of Red Oxide Primer. After satisfactory heat testing of all pipework and prior to the application of insulation, joints and fittings to be painted with one additional coat of Red Oxide Primer.

2.24.27 Steel Pipework

Where particularly specified tubes shall be galvanised. Elsewhere they shall be provided with the manufacturer's standard protective finish.
Pipes for welding shall have plain or chamfered ends. Elsewhere ends shall be screwed unless otherwise specified.

2.24.28 Screwed Joints

Screwed joints shall be provided on mild steel pipework 50mm nominal bore or smaller where the pipework will be accessible on completion. They shall also be provided in other areas where specified and at screwed valves and fittings.
Screwed joints on pipework shall have taper threads made with PTFE jointing tape, or with best quality hemp and jointing paste. The amount of hemp and paste used shall be kept to a minimum and excess removed before painting is carried out. Where excessive use of hemp is observed, the length of pipe and fittings involved shall be replaced with new materials.
No joints shall be made within the thickness of walls or floors.
White jointing compound and hemp shall not be used on domestic water services where the jointing material shall comply with the requirements of the Water Byelaws. Joints on oil pipework shall be unaffected by the action of the oil and remain in a slightly plastic condition when set. Hemp and other fibrous materials shall not be used.
Made screwed joints close to welding operations are to be protected by cooling with wet cloths applied to the made joints.
Made joints are to be remade if adversely affected by welding.

2.24.29 Mechanical Grooved Joints

Grooved joints on mild steel pipe shall be used where required by the Schedules. Joints shall be provided by a manufacturer operating a quality system complying with BSEN.ISO.9000 or its equivalent. They shall only be used where they are compatible with the pressure and temperature requirements of the system.
Joints shall be installed to the manufacturer's requirements using roll formed or cut grooves, prepared to the tolerances required by the joint manufacturer. Joints shall incorporate provision for maintaining earth continuity or be provided with a separate earthing tag. The earthing arrangements shall meet the requirements for earth continuity and equipotential bonding described elsewhere. Joints shall comprise a two piece clamp manufactured from rolled steel to, malleable cast iron or ductile iron as required by the system operating conditions. The clamp shall be secured by two mild steel bolts arranged to positively locate within the clamp and complete with hexagonal nuts.

Joints shall be provided with an-elastomer gasket,-capable of pressure responsive sealing on applicable piping systems. Gaskets shall be suitable for use with the pipe contents, pressures and temperatures.
Where the use of flexible joints on long runs is agreed with the CA, an-elastomeric pressure responsive gasket shall be provided, couplings to allow for expansion and contraction.
Pipework shall be held in proper alignment by the use of guides and supports as recommended by Victaulic. Joints shall be assembled to prevent the pipes separating under pressure. The manufacturer's instructions regarding expansion and contraction allowances, supports and installation precautions shall be followed, support spacing shall not, however exceed those listed elsewhere in this Section. The manufacturer shall provide demonstrations and instruction courses on the preparation and installation of grooved joints to operatives.
Operatives who have not been so instructed shall not be used. The demonstrations shall be by a direct employee of the manufacturer.

Flanges shall be machined right across the joint face and on the edges. Flanges on galvanised pipework, shall be galvanised with all exposed threads painted with a zinc rich paint immediately after the flange is screwed on. Where pipework is to be galvanised after manufacture, welded flanges shall be used.
Mild steel pipe flanges on welded pipework shall be slip-on welding type drilled with a slight taper in the bore and provided with a shaped boss. Flanges shall be welded neck and bore. Long neck welding flanges shall not be used and the practice of burning out the threads of a screwed flange will not be permitted.
Pipework flanges shall, when in position, forming a pair, be flush with one another all round. Flanges shall be bolted together with bright mild steel bolts and nuts complete with washers. Bolts shall not project more than one and a half threads through the nuts. Where high tensile or other special bolts or nuts are required for an arduous application they shall be so identified at each such flange.

Joints between flanges shall be made with full face brass corrugated rings, or other jointing material, purpose-made and not cut from sheets on site. Unusual or corrosive services may require special material. Joint rings shall be fixed concentric with the pipe so that they do not obstruct any of the bore.
Flanges and joints shall be to the correct table to suit the temperature and pressure rating of the services on which they are installed.

2.24.30 Welded Joints

Welded joints shall be provided on mild steel pipework 65mm nominal bore and above and on all concealed and inaccessible pipework. Welding shall be carried out by one of the following processes: i) Oxy-acetylene welding appropriate to the system temperature and pressure. It shall not be permitted on 100mm pipework or above, or flanges of any size. ii) Metal-arc welding appropriate to the system temperature and pressure. The metal-arc processes shall be used on piping greater than 100mm and on all welded flanges.
Welds shall be of clean metal, free from porosity or slag inclusions and of even thickness and contour. They shall be well fused with the parent metal, annealed and finished smooth. Welding metal shall not project into the bore of the pipe.
Prior to welding, the pipe ends shall be aligned and secured in position by a suitable bolted clamp with jack screws for the maintenance of the proper gap at the bottom of the welding groove. The groove shall then be tack welded in several places so as to retain the pipe ends in their correct position during the welding operation.
The bores at the ends of adjacent pipes shall match exactly. Connecting diameters and alignment shall be true within an allowable deviation of + or – 1mm. Welds shall be reinforced on external surfaces, the reinforcement running off smoothly at each end of the weld. Welds which show undercutting will not be permitted.

2.24.31 General Welding Requirements (65mm and above)

Standard fittings shall be used without the use of segmental or cut and shut bends. Each weld run of a welded joint shall have a continuous with cleaning and inspection of the weld by the welder before a further run is applied.
Faulty weld sections shall be removed and made good by welding in lengths of pipe not less than 300mm long.
The end faces of the pipe and fittings shall be machined and bevelled (not flame cut) at right angles to the axis of the pipe bore.
The pipe runs shall have welded on flanges at no more than 10m centres to provide break points in the run.

2.24.32 Competency of Welders

Welders shall hold a certificate of competency recognised by the National Joint Industrial Council stating their grade as a welder. They shall only execute work appropriate to their grade and competency. Copies of their welding certificates shall be issued to the CA before any works are commenced.
Welders shall be supervised by the Contractors qualified welding supervisor.
Welders shall have their names and welders certificate numbers submitted on a list by the Contractor before welding commences.

2.24.33 Welding Requirements

Each welder shall be provided with a steel marker die and shall mark each joint with an individual identification symbol. Alternatively the welders certificate of competency shall be stamped adjacent the joint.

2.24.34 Radiographic (non-destructive) tests of welding

Radiographic examination of steel pipe butt joints shall be in accordance with BS EN 1435. Ultrasonic examination shall be in accordance with B.S. 3923-1. Magnetic particle investigation shall be in accordance with BS EN ISO 9934-1.
Use B.S. 2971 as the basis for acceptance fault limitations, rectification of welds and visual requirements.
The examinations shall be carried out by an agreed independent inspecting authority and the decision on the acceptability of any weld shall be binding.
On completion of the first ten production welds made by each welder, five of these welds and 10% of subsequent production welds shall be selected for examination. Should any weld be rejected or require rectification then a further two welds by the same welder shall be selected for examination. In the event of a further failure in these two welds the whole of the welds performed by a particular welder may be liable to rejection or require the provision of radiographic evidence of the acceptability of all the welds in question.
Radiographic examination testing procedures shall be advised to all interested parties, indicating Inspection Authority, the method to be employed, the location, timing and protection measures to be instituted by way of barriers, shields , warning lights, notices and emergency procedure. Rejection and rectification shall follow the procedure for radio-graphed welds.

2.24.35 Records of Inspection

The Contractor shall provide and keep accurate records of inspections, welding procedures, tests and dates. Each result shall have the welders number, appropriate to the weld, recorded on it together with a description of the weld location. Successful joints and failed joints shall be recorded along with any rectification work carried out.

2.24.36 Protection of Persons and Material

The welding area shall comprise opaque screens positioned around the fusion operations to prevent weld flash being visible to any persons other than the welder.
The welding operation shall include the use of heat-resistant mats to prevent fire and damage to other materials during the welding procedure.
Two portable fire extinguishers shall be located in the immediate vicinity of the welding operation for emergency use and shall be suitable for the type of hazard.
Where there is a possibility of unacceptable fume concentration the Contractor shall provide an adequate means of ventilation.

2.24.37 Failure of Joints During Pressure Test

The CA shall be advised of any failed joints during the pressure test, which shall be rectified in accordance with his instructions at the Contractors expense, and be recorded on the weld test certificates accordingly.

2.24.38 Copper Pipework

Copper tubes shall be solid drawn and shall be half hard temper in accordance with Table X to BSEN1057. Soft copper tubes shall comply Table Y.
Where required soil, waste and rainwater pipework shall be prefabricated from copper tube in accordance with Table X. Fabrication shall be carried out by a specialist copper pipework fabricator. Copper to copper joints shall be silver alloy brazed using copper-phosphorous alloys Type CP4, without the use of flux.
Copper to gunmetal joints shall be brazed using copper-phosphorous as before described with the use of a suitable flux.

2.24.39 Capillary Jointing

Joints in copper pipework shall be by means of factory made non-dezincifiable couplings or by brazing using the correct forming tools. Couplings shall be fitted strictly in accordance with the manufacturer's recommendations. Particular attention shall be given to cleanliness and lack of distortion of the tube and fitting and to ensuring full insertion depth in fitting.
Capillary joints shall be made by thoroughly cleaning sockets of fittings and ends of pipes, and by using a suitable flux as described below. Capillary fittings shall have integral solder rings. No additional solder shall be added to the joint and all surplus flux shall be removed. White jointing compound and hemp shall not be used on domestic water services.

2.24.40 Soldered

Soldered joints shall be made in accordance with HVCA publication TR7 'Guidance on Soft Soldering for Pipe Jointing of Copper' using lead free solders. Excessive use of flux or self cleaning flux will not be permitted. The Mechanical Services Installer shall obtain agreement from the Local Water Authority for any flux and solder proposed. The CA reserves the right to have any pipework not complying with this clause, removed.

2.24.41 Brazed

Brazing shall be carried out in accordance with HVCA publication TR3 'Brazing and Bronze Welding of Copper Pipework and Sheet'. Couplings shall be used where joints are visible. Elsewhere they may be made by properly belling or swaging one pipe to allow insertion of the other. Brazed joints shall be made using filler rods and appropriate fluxes. Bronze welding shall not be permitted.

2.24.42 Precautions During Brazing

The Contractor shall provide heat shields and heat sinks for all brazed joints.

~~2.24.43 Screwed Joints~~

~~Screwed joints on copper pipework shall be provided where specified and at screwed valves and fittings. Screwed joints shall have tape threads made with PTFE jointing tape or such other jointing as is acceptable to the Local Water Authority.~~

2.24.44 Flanged Joints

Flanges shall be machined right across the joint face and on the edges. Flanges shall, when in position, forming a pair, be flush with one another all round. Flanges shall be bolted together with bronze bolts and nuts complete with washers. Bolts shall not project more than one and a half threads through the nuts. Joints between flanges shall be made with full face brass corrugated rings, or other jointing material, purpose-made and not cut from sheets on site. Joints on water services shall made with a material approved by the Water Research Centre. Unusual or corrosive services may require special material. Joint rings shall be fixed concentric with the pipe so that they do not obstruct any of the bore. Flanges shall be to the correct table to suit the temperature and pressure rating of the services on which they are installed.

2.24.45 Fittings

Copper fittings shall be capillary with integral solder ring. Compression fittings in the pipe line (excluding final connections to equipment) are not permitted. End feed capillary fittings are not permitted.
Compression connections to line equipment shall not be installed in inaccessible locations. Fittings for copper pipes shall be of a non-dezincifiable pattern. ~~Connections to screwed valves, fittings and equipment shall be bronze or gunmetal.~~ All solder fittings shall be solder ring type, manufactured exclusively by Yorkshire (PeglerYorkshire) up to 54mm. Fittings of 67mm and above shall be manufactured exclusively by Yorkshire (PeglerYorkshire) and be brazed.

2.24.46 Galvanised Pipework

Pipework of 200mm and above shall be flanged or grooved both ends and galvanized after manufacture.
Pipework shall be galvanized prior to threading. When threaded pipework has been fixed in position, all exposed threads shall be painted with a “cold galvanizing” solution Pipework that has welded-on flanges shall be flanged before galvanizing. Where galvanized pipework is connected to copper pipework, the Contractor shall use a dielectric material to prevent electrolytic action taking place.

2.24.47 Flexible Pipe Connections

Where shown on the drawings flexible pipework shall be provided with integral screwed or union connections. The whole flexible pipework assembly shall be pressure and temperature rated for the particular system it is to be used for.
Flexible pipework connections shall not exceed 400mm in length and shall be arranged in long- radius sweep bends.
Flexible pipework shall be woven mesh reinforced to prevent kinking of the bore at bends. Three Victaulic Style 77 couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief. The couplings shall be placed in close proximity to the source of the vibration.

2.24.48 MDPE Pipework

2.24.49 MDPE Tube

Medium density polyethylene tubes coloured blue shall be used for underground water mains. Medium density polyethylene tubes coloured yellow shall be used for underground gas services. The Contractor shall obtain approval from the Engineer prior to using MDPE pipework for other services and shall only be offered if it is declared within the Contractor’s tender proposal.

2.24.50 Electro Fusion Welded Joints

Medium density polyethylene pipework 50 mm diameter and above shall be joined by electro fusion welding. Welding shall be carried out using couplers or socketed fittings manufactured to permit alignment and insertion depths to be properly controlled during the jointing process. Joints shall be prepared in accordance with the manufacturers recommendations. A hydraulic clamp, designed for the application by the manufacturer shall be used to ensure that pipework and coupling are secure during the jointing process and subsequent cooling period. Fusion shall be carried out in accordance with the manufacturer’s instructions, particular attention being paid to cleanliness, voltage and fusion times. Electro fusion welding shall only be carried out by a qualified electro fusion welder, having been trained on a course recommended by the Water Research Centre.

2.24.51 Mechanical Joints

Medium density polyethylene tube less than 50 mm diameter shall be jointed using dezincification resistant alloy underground compression fitted and satisfying the BS pull-out test.

2.24.52 ABS & PVC Pipework

Pipework systems and their fittings shall be approved for use with drinking water delivery systems by the Water Regulations Advisory Scheme (WRAS). Unplasticised PVC pipes for domestic water services, soil, waste and ventilation systems general water services shall be of the grade and thickness required to suit the system working pressure.
ABS pipes for water services shall be of the class required for the maximum system working pressure.
UPVC pipework can also be used in waste and ventilation systems.
PVC-C pipework from Friatherm from Durapipe UK Ltd or Hep20 from Wavin may be used for heating and domestic hot & cold water services. Different manufacturer's systems may not be mixed. All pipework, fittings and accessories shall be supplied by an authorised distributor and installed by the Contractor strictly in accordance with the manufacturer's instructions and procedures.
2.24.53 Pressure Ratings
2.24.54 Pipes: Metric sizes in accordance with the dimensional and testing requirements of DIN 8079: Dimensions. DIN 8080: General Quality Requirements, Testing. Pressure Rating PN 25 at 20°C up to size 63 mm, PN 16 at 20°C for 75mm, 90mm, 110mm, and 160 mm sizes.
2.24.55 Fittings: Metric sizes in accordance with the dimensional and testing requirements of BS 7291, Part 4 1990 – PVC-C pipes, fittings and solvent cement (where applicable). Pressure Rating as pipes.
2.24.56 Matching system The products shall be from a single manufacturer to ensure complete integrity, quality, and compatibility between pipes and fittings. Manufacturers warranties may be compromised if a system is installed with materials from various manufacturers. Where this is not possible, then any alternative products should be confirmed as being at least equivalent to that which is normally supplied.
2.24.57 Quality system Pipes, fittings and valves shall be manufactured in an environment which operates a Quality Assurance System assessed to BS ISO 9001.
2.24.58 Design & installation The installation shall be carried out by competent persons. The Contractor shall provide technical documentation relating to the pipework manufacturers recommended Design and Installation procedures, and will have been trained with regards to the correct procedure for solvent cement jointing. Specific attention shall be paid to the following:
2.24.59 Supports and clips All horizontal/vertical pipework shall be secured using 2-part metal pipe clips and/or plastic pipe clips, installed in accordance with manufacturers recommendations.
All horizontal pipework up to and including size 32mm may be supported using a proprietary 'tray system'
to reduce the number of supports required.

2.24.60 Thermal expansion

i) Hot water flow & return pipes, and heating pipework shall include sufficient provision for thermal expansion, by utilising the natural flexibility at all 90o changes in direction, by inclusion of expansion loops as necessary to provide additional flexibility, and by inclusion of fixed points at strategic locations to control direction of thermal expansion, in accordance with manufacturer's recommendations.
ii) Where there are insufficient changes in direction, and where space constraints prevent the use of expansion loops, then it is acceptable to utilise flexible rubber bellows. These must be installed in accordance with the bellows manufacturers recommendations.

2.24.61 Fixed Points

i) Vertical Pipework Two oversize sections (half clamps) shall be secured to vertical pipework immediately to each side of the 2-part metal pipe clips, using component adhesive.
ii) Horizontal Pipework For pipe sizes 50mm and above, installation shall be in accordance with the method as described for vertical pipework.
For pipe sizes under 50mm the 2-part metal pipe clips shall be securely tightened with no half clamps fitted. iii) Fixed (Anchor) Points in conjunction with Expansion Bellows A galvanised mild steel support backing plate, suitably secured with an angle bracket, shall be used to form a stub-flange assembly.
Pipe spacing distances shall be calculated, using the following formula, which shall be applicable to all pipe sizes:
• First bracket either side of Bellow at centres of 4 x pipe outside diameter
• Second bracket at centres of 8 x pipe outside diameter
• Subsequent bracket(s) at recommended support centres.

2.24.62 Jointing

The manufacturer shall offer solvent cement specially formulated to minimise any adverse effects on the environment during installation of the pipework system.
Joints in uPVC or ABS water service pipework shall be solvent welded in accordance with the pipe manufacturer's instructions.
Unplasticised PVC soil, waste and ventilating pipework shall be jointed using ring seal or solvent welded joints. The jointing method shall make due allowance for thermal expansion.
Joints between uPVC pipes and cast iron pipes shall be made using cast iron adaptors incorporating a synthetic rubber ring seal.
UPVC pipework shall be jointed using ring seal or solvent welded joints. The jointing method shall make due allowance for thermal expansion.
Joints between uPVC pipes and cast iron pipes shall be made using a cast iron boss pipe to uPVC, seal ring joint, to BSPT adaptor. The adaptor shall be screwed into the boss pipe with PTFE tape as the sealing medium.
Joints for PVC-C Friatherm pipework and fittings shall be secured using only Friatherm proprietary cold solvent-weld adhesive (and primer where required – pipe sizes 110mm & 160mm) in accordance with the manufacturer's instructions.

2.24.63 Connections to Valves and Ancillary Equipment

All connections to ancillary equipment, and to metal valves, up to and including size 63mm (50mm/2" bore) shall be by means of proprietary threaded fittings, or flanges. All connections to ancillary equipment, and to metal valves over size 63mm (50mm/2" bore) shall be by means of proprietary flange connections.
2.24.64 Intumescent sleeves Pipework size 50mm and above, passing through a designated fire wall or floor shall, where necessary to meet Statutory Building Regulations, shall be fitted with intumescent sleeves with a fire rating in accordance with Building Regulations.

~~2.24.65 Polybutylene (PB) Pipework~~

~~Polybutylene pipework and fittings shall be used (where specified in the particular specification) for internal distribution of domestic hot and cold water services (up to 70°C continuous use and 85°C intermittent use). For heating applications, refer to Underfloor Heating section.~~
~~PB pipework shall not be used for oil pipelines.~~
~~Only pipe cleaner and sealant specifically approved by the pipe and fitting manufacturer shall be used.~~
~~The Contractor shall provide samples of PB pipe, valves, fittings and cleaner, for approval in writing and retention on site. Orders shall not be placed without approval in writing. Upon completion of the system, pipework shall be flushed with potable mains pressure water and disinfected in accordance with manufacturers instructions.~~
~~The completed system shall be tested to 15 bar pressure and shall be maintained throughout the testing period of 3 hours.~~
~~Allowance for pipework expansion shall be included within the layout of the pipework in accordance with the manufacturer's instructions.~~

2.24.66 Fittings and Valves

Unless specified otherwise, all associated valves and fittings shall be of PB and/or brass manufacture.
PB isolating valves for LPHW, CHW and condenser cooling water shall be:

- 50mm and below, gate type having a bronze body screwed BSPT, with inside screw, non rising stem, threaded bonnet and a bronze trim.
- 65mm and above, gate type having a cast iron flanged body, with inside screw, non rising stem, bolted bonnet and a solid wedge.

PB isolating valves for hot and cold water services shall be:

- 50mm and below, gate type having a bronze body screwed BSPT, with inside screw, non rising stem, threaded bonnet and a solid wedge.
- 65mm and above, gate type having a bronze flanged body , with inside screw, non-rising stem, threaded bonnet and a solid wedge.

PVC-C ball valves shall be used for pipe sizes up to and including 63mm, meeting the resistance pressure of DIN 3441 , allowing bi-directional flow and floating ball, and complete with double socket disconnecting ends and removable seals PVDF flanged butterfly valves shall be used for pipe sizes over 63mm, meeting the resistance pressure of DIN 3441 , allowing bi-directional flow and having valve body holes to allow connection to flanges drilled in accordance with DIN 8063. Brass ball valves and gate valves shall be used directly or with adapters to flanged or threaded connectors.

2.24.67 Joints

Jointing shall be carried out in accordance with the manufacturers instructions and shall be socket fusion, electro fusion or compression.
Only fully trained installers shall be employed, utilising the correct assembly tools, melting and jointing times.
Cleaners shall be correctly applied to pipe ends and sockets before fusion and electro fusion jointing with cleaning pads. After

fusion jointing a ring of polybutylene will be visible on the outside of the pipe as evidence of the joint being completed. Brass compression fittings shall include internal pipe sleeve as integral part of the fitting with grip ring to hold the pipe together. Where shown on the drawings, to enable disconnection, socket unions shall be used on pipes up to and including 63mm and flanged joints shall be used over 63mm.
Screwed adaptor fittings shall be used for screwed joints to appliances up to and including 50mm and flange adapters shall be used for connections to pumps, tanks or equipment above 50mm.
The finished pipework system shall be smooth, free of internal and external mechanical imperfections, and internally shall have a smooth appearance.

2.24.68 Cast iron pipework

2.24.69 Cast Iron Tube
Cast iron pipes for use above ground on sanitary or rainwater systems shall be suitable for jointing with mechanical couplings. Where particularly required they shall be suitable for spigot and socketed jointing.
Cast iron pipes for use below ground on drainage systems shall be suitable for spigot and socketed jointing or jointing with mechanical couplings.
Cast iron pipes for underground water services shall be externally coated as required to suit the ground conditions. Internal coatings shall be applied to the requirements of the water undertaker. Cast iron pipes for underground gas services shall be externally coated as required to suit the ground conditions.

2.24.70 Coupling Joints

Joints on cast iron pipework shall be made with mechanical couplings appropriate to the grade and type of pipe material. Joints and couplings shall be provided by the manufacturer as an integral part of the system.
They shall be suitable for the pressure requirements described elsewhere. Anchors and guides shall be provided in accordance with the manufacturer's recommendations. Joints between spigot and socket cast iron pipes and fittings shall be made by packing joints with firmly caulked untarred yarn, to one third of the joint depth, the remainder being filled with molten lead or fibrous lead yarn and firmly caulked. Joints between cast iron pipes and spigots of WC's shall be made using polypropylene flexible couplings incorporating molded rubber seal rings. Joints to existing cast iron pipework shall be made with the appropriate adaptor pieces and as appropriate to the service.

2.24.71 Flanged Joints

Flanges shall be machined right across the joint face and on the edges. Flanges shall, when in position, forming a pair, be flush with one another all round. Flanges shall be bolted together with bright mild steel bolts and nuts complete with washers. Bolts shall not project more than one and a half threads through the nuts. Joints between flanges shall be made with full face brass corrugated rings, or other jointing material, purpose-made and not cut from sheets on site. Unusual or corrosive services may require special material. Joint rings shall be fixed concentric with the pipe bore so that they do not obstruct any of the bore. Flanges shall be to the correct table to suit the pressure rating of the services on which they are installed.

2.24.72 Cast Iron fittings

Fittings for cast iron pipe shall be suitable for jointing with mechanical couplings or provided with spigots and sockets as required. Where mechanical couplings are used adequate earth continuity bonding shall be provided.

2.24.73 Under Floor Heating

Refer to Section Heating Installations

2.24.74 Sanitary and Rainwater Pipework

Vertical pipework shall be supported by holderbats plugged and screwed to the structure, unless otherwise agreed with the CA. Holderbats shall be of the two piece type. For cast iron and uPVC pipework the bracket shall form a strap fabricated from 4mm thick mild steel with a minimum width of 25mm, the whole being hot dip galvanised (610 g/m2) or nylon coated after fabrication.
Copper and uPVC pipe holderbats shall be manufactured from brass or bronze.
Holderbats on MUPVC pipe shall incorporate adequate provision to prevent damage to the pipe. Alternatively, where suitable, they may be manufactured from plastic. Horizontal cast iron and uPVC pipes shall be supported by two piece mild steel pipe rings with a 15mm socket welded on. Pipe rings shall be provided with a drop rod and turnbuckle. The ends of the drop rod shall be screwed to a back plate fixed to the structure or to supporting steelwork.
After fabrication brackets shall be hot dip galvanised. Copper and uPVC pipes shall be similarly supported but with a brass or bronze pipe ring with ungalvanised drop rod. uPVC pipes shall be protected from damage by the support. Horizontal pipework adjacent to walls shall be secured by holderbats screwed or plugged to the walls. Materials shall be as listed for vertical pipework.
Where drainage, condensate and rainwater pipework is to be insulated then wood blocks, extending to a minimum of 25mm beyond the pipe ring shall be fitted to allow the insulation and finish to be butted to the block and the vapour seal terminated on the block. Blocks shall be the same thickness as the insulation.

2.24.75 Drainage and Rainwater Pipework

Horizontal pipework shall be laid to gradients. Vertical pipework shall be parallel with vertical surfaces. Flexible joints in pipework shall not be made within the thickness of the structure or where they would later be built in. Jointing material shall not project into the bore of pipes, fittings or appliances.
Access caps or plates shall be fitted at ends of all horizontal pipework, at junctions and changes of direction. Access plates shall be fitted at each floor level immediately above the highest connection, at the foot of each vertical stack and at junctions to horizontal connections to enable the system to be internally cleaned and rodded. Access plates shall be provided on vertical stacks, at every level, above the rim of adjacent sanitary ware.
Cleaning eyes shall be provided on the end of horizontal waste floats and rodding eyes at the ends of horizontal soil manifolds, turned up to above the rim of adjacent WC pans. Rodding eyes or access fittings shall be provided at changes of direction on suspended soil or waste pipework. Floor gullies shall be provided with drain access, either internally within the fitting or externally within the pipe run. Soil and waste branches shall be swept type.
Main branch ventilating pipes shall be run above spill over level of fitments except where shown, and if connected to main soil, soil waste or waste pipes, the connection shall be at a point above spill over level of the highest sanitary appliance connected to such pipe. At the penetration of all roof levels a suitable water seal and weathering shall be provided. Pipe stacks shall be carried up full bore above eaves or roof levels. Termination of soil, waste or ventilation pipework shall not be closer than 3 metres to any opening window, door or ventilation intake. Should this be unavoidable, the pipework shall be terminated 900mm above any such opening.

2.24.76 Pipework Spacing

Element	Minimum Clearance
Walls	25mm
Ceilings	25mm
Finished Floors	50mm above top of skirting or 150mm (whichever is greater)
Adjacent pipes (both insulated)	25mm
Adjacent pipes (both uninsulated)	150mm
Adjacent pipes (one insulated)	20mm
Insulated pipes adjacent to conduit or trunking	50mm
Uninsulated pipes adjacent to conduit or trunking	100mm
Adjacent to electrical cables not in conduit or trunking	150mm

2.24.77 Pipework Support Spacing

Nominal bore (mm)	Intervals for all vertical runs (m)	Intervals for horizontal runs Un-insulated (m)	Intervals for horizontal run Insulated (m)
Mild steel pipework			
15	2.5	2.0	2.0
20	3.0	2.5	2.5
25	3.0	2.5	2.5
32	3.0	3.0	2.5
40	3.5	3.0	2.5
50	3.5	3.0	2.5
65-100	4.5	3.5	3.5
125	5.5	4.5	3.5
150	5.5	5.5	4.5

Nominal bore (mm)	Intervals for all vertical runs (m)	Intervals for horizontal runs Un-insulated (m)	Intervals for horizontal run Insulated (m)
Copper pipework			
15	2.0	1.0	1.0
22	2.0	1.5	1.5
28	2.5	1.5	1.5
35	3.0	2.5	2.0
42	3.0	2.5	2.0
54	3.0	2.5	2.0
67	3.5	3.0	2.5
76	3.5	3.0	2.5
108	3.5	3.0	2.5

Nominal bore (mm)	Intervals for all vertical runs (m)	Intervals for horizontal runs Un-insulated (m)	Intervals for horizontal run Insulated (m)
Cast Iron Pipework			
All sizes	1.5	1.5	1.5

Nominal bore (mm)	Intervals for all vertical runs (m)	Intervals for horizontal runs Un-insulated (m)	Intervals for horizontal run Insulated (m)
UPVC & MUPVC Pipework			
<25	0.8	1.2	1.0
32-40	1.0	1.8	1.5
50	1.0	2.0	1.8
75-100	1.5	2.4	2.0
150	1.5	2.7	2.4

2.24.78 Floor Screeds

Where pipework conveying water, either open or closed circuit, except where part of a floor warming circuit, is to be concealed within the floor screed it shall be installed in a purpose made galvanised sheet metal floor duct manufactured by "Screeduct". The ducts shall be installed at a level which allows the floor covering to finish flush with the finished floor.
Ducts shall be fixed to prevent movement during screeding and joints sealed with waterproof tape. Where ducts pass through fire barriers they shall be adequately stopped. After pressure testing, insulation and commissioning the duct covers shall be fixed down. Fixings shall be removable to allow for subsequent removal of the cover if necessary.
Pipework for gas services may be buried in floor screeds provided the method complies with the Gas Safety (Installation and Use) Regulations.

2.24.79 Buried Pipework

The Contractor shall be responsible for the correct setting out of the Works.
Finished ground levels, inverts and sizes of existing services shall be checked before the commencement of any works. The CA shall be notified immediately of any incorrect levels or sizes. Prior to commencement of work, full details of finished site ground levels shall be obtained. Exposed components of the system shall be installed relative to the levels described elsewhere or to the manufacturers recommendations.
The approximate position of services and associated works shall be as shown on the drawings. Such positions shall be checked before proceeding with any works to avoid interference with existing structures and other existing site services.
Excavation work adjacent to existing structures shall not undermine the stability of the structure. Any area of concern shall be clarified with the CA before work proceeds.

2.24.80 Excavation & Trenching

Excavations shall be cut and trimmed to the line, level and depth shown on the drawings, or as otherwise directed. Unless agreed otherwise excavations shall be formed with vertical sides.
Dimensions of excavations shall not be larger than listed herein, with allowance for timbering, shuttering or other temporary work where required.
Excavations exceeding the width or depth stated shall be refilled with C7.5P grade concrete or equal fill to reduce the excavation to the listed dimensions. If any trench is cut to a greater width than specified the CA shall be informed to enable a suitable alternative bedding to be agreed.
Where a concrete or granular bed or surround is required the excavation shall be taken out to the overall dimensions of the bed or surround.
Material for backfilling purposes shall be placed at a safe distance from excavations. It shall not be placed closer than a distance equal to the depth of the excavation, unless suitable working and safety arrangements are made. Care shall be taken when placing material to minimize the damage to the existing surface finish.
Excavated material suitable for use as backfill shall be adequately protected to maintain its suitability. Surplus excavated material shall be removed from the site unless directed otherwise by the CA.
Excavations shall be in open cut unless agreed in writing by the CA. Soft spots within the trench bed shall be dug out to the satisfaction of the CA, refilled with a suitable imported material and compacted. Trial holes shall be made ahead of work to ascertain the positions of existing services and obstructions.
Obstructions on the same alignment as the proposed new works shall be reported to the CA before removal. The extent of the removal shall be agreed with the CA.
Works carried out prior to the completion of heavy earth moving operations or other abnormal loads shall be suitably protected to the satisfaction of the CA, and to the requirements of the Health and Safety Executive.
Excavation for any section of the works shall not commence until a complete supply of pipes, fittings and bedding materials are available on site for the entire section of the Works. Excavations shall be cleared of water and shaped to prevent any accumulation of water either in or adjoining the excavation or the spoil.
If necessary sumps shall be constructed and maintained clear of excavations for the works, so that water is at all times kept below any permanent works. Ground water and water arising from construction operations shall not be permitted to enter permanent drainage systems.
The Contractor shall, at no additional cost, repair/replace any pipes, cables, drainage and all associated equipment that may be damaged whilst undertaking the excavation and reinstatement works.

2.24.81 Trench Supports

The Mechanical Services Installer shall design, provide, maintain and remove any planking, strutting and shoring required for adequate temporary support of the excavation. Shoring shall be of sufficient strength to ensure the safety of personnel and to prevent damage to the works or to foundations of adjoining buildings and structures. Should a trench slip or fall occur it shall be made good to the satisfaction of the CA.
Supports of timbering with poling boards and runners, or steel trench sheeting shall be used according to the ground conditions. They shall be designed to prevent loss of ground during excavation and to ensure that backfilling can be carried out in accordance

with the specified requirements, leaving no voids.
Where possible trench supports shall be removed from the trench prior to backfilling. Where supports cannot be progressively withdrawn as the trench is backfilled and compacted, the CA shall be informed prior to pipe laying so that a suitable bedding can be adopted to cope with subsequent settlement of the trench fill when the support is finally withdrawn.

2.24.82 Pipework Bed & Surround

Pipework bed to underside and sides of the pipe, shall be 100mm to the of well rammed clean sand throughout the length of the service. Where granular beds and surrounds are to be installed care shall be taken not to contaminate the material with solids of larger nominal size or with fines. Alternatively for ductile iron pipes, can be laid on similar thickness beds of granular material or weak cement sand mix, especially on steep gradients.
Should the site have a high and mobile water table, areas of granular bed and surround shall be encased with a geotextile permeable membrane of agreed pattern, to prevent contamination of the material by fines from the surrounding subsoil.
Pipework laid with less than 600mm cover adjacent to a building structure, beneath a site access route or which may be adversely affected by traffic shall be encased in 150mm thick concrete
Where a concrete bed and surround is provided, a vertical joint of 25mm minimum thickness shall be formed at each pipe joint with compressible polystyrene or fibreboard sheet to retain the flexibility of the pipeline.
The material filling the gap shall be shaped around the pipe joint to the manufacturers recommendations, and shall extend through the full cross sectional area of the surrounding concrete. Pipe joints shall in addition be wrapped with two coats of mastic bandage tape before concreting.

2.24.83 Installation Cold Water

Pipework shall be copper, ductile iron or polyethylene buried at a depth of between 900mm and 1350mm to the top of the pipe to suit local conditions and prevention against freezing (or as shown on the tender drawings).
Gas pipework shall be in accordance with British Gas and not less than 600mm deep. No existing metallic main shall be cut until it is ascertained that the main does not form part of any electrical system or cathodic protection system.
Soil conditions shall be checked by the Mechanical Services Installer by laboratory analysis of typical samples to ensure that the soil is not aggressive to the proposed pipework material. Copies of the report shall be forwarded to the CA for comment prior to the pipework being commenced. Pipework material shall be suitable for the ground conditions or the pipe shall be properly protected from such ground conditions.
Pipes shall generally be laid to the contours of the ground with a minimum cover of 750mm and a maximum of 1300mm (or as shown on the tender drawings). Pipes shall not be laid on their collars or on bricks, tiles or other temporary supports.
Pipes shall be cut perpendicular to the axis without splitting or fracturing, and with a minimum of damage to any protective coating or lining. Any such damage shall be made good immediately.

2.24.84 Thrust Blocks

Where required, hydrant valves, bends, tees, blank ends and changes of direction on water pipes, other than MDPE pipes, of internal diameter 50mm or greater shall be provided with thrust blocks of mass concrete construction.
Blocking shall be placed between solid ground sides and enclose the fitting to be anchored. Unless otherwise indicated or directed the base and thrust-bearing sides of thrust blocks shall be poured directly against undisturbed earth.
Where excavation is in virgin soil the sides and face shall be hand trimmed prior to placing the concrete. Where excavation is in soil previously compacted to 98% standard Proctor maximum dry density, the excavation and placing of concrete shall be as for virgin soil. Where a thrust block is to be located in a zone not compacted to 98% standard Proctor, the area local to the block position shall be excavated, the block cast, and the soil compacted to 98% standard Proctor.
The zone of compaction shall be 1 m deep in front of the block and thereafter sloping at 45deg. to the ground surface.
Fill on all sides of the block shall be raised simultaneously with surfaces of fill maintained at approximately the same levels, and the fill adjacent to the non-bearing faces of the blocks shall be nominally compacted in 150mm lifts, so that the block is not displaced by fill compaction.
After casting of thrust blocks the pipework shall not be filled or tested for a minimum period of 7 days. Ends of pipes shall, during the course of the Works, be closed with purpose-made temporary stoppers.
Precautions shall be taken to prevent flotation of the pipeline. Full details of the size and location of thrust blocks shall be shown on the Record Drawings.

2.24.85 Marker Tape

Buried pipework shall be protected from damage from any future excavation by the use of proprietary plastic warning marker tapes, or 150mm wide mesh run along the length of the pipe, during backfilling, and positioned 150mm below ground level, the tape or mesh shall have a stainless steel wire for pipe detection on plastic systems.

2.24.86 Backfilling

On completion and subsequent to inspection and testing the excavation shall be refilled. Where applicable, existing surface levels shall be reinstated to the satisfaction of the Architect or CA. Backfilling shall, wherever practicable, be undertaken immediately the preceding operation has been completed. Except where special backfill material is specified, trenches shall be refilled with suitable excavated material.
Excavations shall not be backfilled until the pipework has been hydraulically tested as described within the section Testing & Commissioning. A final test shall be undertaken and witnessed by the CA after backfilling has been completed.
The initial layer of backfill material shall be 100mm of well compacted sand and be free from all stones and organic material. Backfill shall be carefully placed onto the pipe surround and compacted in 300mm maximum layers using hand tools, up to at least the first 300mm above the top of the pipe or special surround.
Filling above the initial layer shall be deposited in layers not exceeding 300mm loose depth, and compacted to a dry density not less than that of the adjoining soil. Trench supports shall be withdrawn ahead of the layer to be filled, care being taken to keep the sides of the trenches solid and to fill the spaces left by the supports. Mechanical appliances may only be used when there is a minimum of 600mm of material above the crown of the pipe.
The appliance shall be suitable for the conditions and not damage or displace the pipes. Backfilling over concrete surrounds shall not commence until at least 24 hours after placing concrete. Imposed loads shall be restricted until after 72 hours. Below ground pipework shall be identified by a durable marker tape suitably worded to identify the service.
Tapes shall be worded in block letters with wording at least 50mm high. Marker tapes shall be installed at a depth no greater than 300mm below finished ground level and shall incorporate, a traceable element suitable for monitoring by electronic survey.

2.24.87 Existing Services

The proposed route of the new supply/supplies may pass within areas that contain gas/water/heating pipework, electrical, telecommunications, I.T. and data cables, storm and foul drainage.
Where record drawings showing existing underground services are included for use by the Contractor they must not assume that the locations shown are exact or that every service is shown.
A CAT (cable avoidance tool) must be used to attempt to locate all existing pipework and electrical supplies prior to any excavations. Lifting of drain covers must be carried out to evaluate the depth and direction of drains.
The Contractor is to have allowed for costs to connect to the existing gas service within five metres of the route shown on the drawings.

2.24.88 Valves

Valves and cocks shall be provided to permit the isolating of equipment or sections of the installation and for balancing of flow quantities. They shall be located to allow ease of operation and servicing. Where concealed behind access panels or similar, they shall, wherever practical, be grouped for ease of access. Valves and cocks located where unauthorised interference is possible, shall be fitted with key operated spindles. Alternatively, on large valves they shall be securely locked in position by means of a padlock. Wheeled valves on hot services shall be fitted with 'cool' pattern wheels. Valves and cocks exposed in rooms shall be provided with easy-clean bonnets Seats, discs and packing shall be suitable for the operating conditions to provide efficient service with minimum maintenance. Valves and cocks shall be manufactured from non dezincifiable materials. Spare asbestos free gland packing, of the appropriate grade and sufficient to repack each gland, shall be provided to the Employer. Screwed valves and cocks shall be fitted with a union on the 'dead' side.
Valves or cocks on domestic hot and cold water services shall be Water Regulations Approved and stamped accordingly.
Six air cock keys, drain cock levers, lockshield valve keys and levers for any other valve or cock provided in the Works shall be handed over to the CA for each type and size of valve or cock. Two keys for each padlock shall also be provided together with a differential pressure gauge and connections for the balancing valves. Provide and install in the positions indicated in plans and in positions specified pipeline valves where shown on the tender drawings and as detailed in the Particular Specification and Schedules.
Drain cocks in boiler rooms and plant rooms and for circulation mains are to be of the full bore gland pattern with removable hose-union tails.
Drain cocks elsewhere in buildings are to be of Type A. Valves on insulated pipework shall be provided with extended stems to ensure that the operating lever or wheel clears the finished insulation.
All valves shall be include compression, union screwed, grooved or flanged connections, as applicable to the type and size of valve, and be removable without cutting the installed connecting pipework.
2.24.89 Recommended Manufacturers: Crane, Hattersley, Oventrop, Pelger, Reliance Water

2.24.90 Isolating valves Service/Appliance Type Size

Appliance	**Type**	**Size**
Domestic hot water LTHW, chilled & condenser water	Lever or Allen key operated ball valve	Up to 50mm
WCs	Screwdriver operated ball valve	To suit appliance
Domestic hot water LTHW, chilled & condenser water	Wafer or grooved-end butterfly	65mm & above
Filter type ball valves	A dezincification resistant copper alloy body and ball, combined ball valve and fully isolated integral stainless steel strainer, with PTFE seat and packing. Screwed.	15-50mm
Mains & cold water service pipes at sanitary fittings	Handwheel stop cocks	Up to 28mm
Mains & cold water service pipes at sanitary fittings	Lever operated	35 to 50mm
Mains & cold water service pipes at sanitary fittings	Lever operated	65mm & above
Draining water carrying pipelines	Lockshield drain cock	10-20mm
Commissioning sets & double regulating valves with pressure tappings	Screwed connections	Up to 50mm
Commissioning sets & double regulating valves with pressure tappings	Flanged connections	65mm & above

2.24.91 Cold Water Services

Type	Connection Size	Description
Principle Stop Valves - All external CWS valves in the supply system including the first MCWS valve serving a building:		
Isolation Above Ground	15 to 50mm	Copper alloy, screw down pattern to B.S. 1010 Part 2
	65mm & above	Cast iron with internal surface protection, flanged, wedge gate valve to BS 5163 inside screw, non-rising stem, bronze trim, with hand wheel and indicator
Isolation – Below Ground	15 to 50mm	Copper alloy, screw down type to BS 5433.
	65mm & above	Cast iron with internal surface protection, flanged, wedge gate valve to BS 5163, inside screw, non-rising stem, bronze trim, key operated.
Service Valves - All internal CWS valves in the distribution system including sub-distribution parts of systems within a building.		
Isolation	15 to 50mm	Dezincification resistant copper alloy, screwed or copper capillary union, solid wedge gate, valves to BS 5154, non-rising stem, screwed bonnet. wheelhead sizes 15 Ø -50 Ø: Dezincification resistant copper alloy, screwed or copper capillary union, solid wedge gate valves, to BS 5154, non-rising stem, screwed bonnet. Lockshield pattern, sizes 15-50mm.
Butterfly valves	Wafer type between flanges 65-300mm	Cast iron or SG iron lugged wafer type generally to BS 5155 'Nitrile' lining, nickel plated disc, lever operated to 300mm size. Use stud bolts and nuts to securely attach the wafer valve to the flange holding back water pressure during maintenance. Padlock valves required for regulation.
Stop cocks	15 to 50mm	All local MCW isolation of single or closely coupled group of draw-off points. Where exposed to view in decorated areas of the building use chromium plated ball valves.
Ball valves	Screwed 15 to 50mm	A dezincification resistant copper alloy body and ball,screwed or copper capillary union or compression to BS 5154 combined ball valve, PTFE seat and packing.
Wedge valves	15 to 50mm	Dezincification resistant copper alloy, screwed or copper capillary union or compression to BS 5154, non-rising stem, screwed bonnet and solid bronze wedge
Check valves	Screwed 15 to 50mm	Dezincification resistant copper alloy, swing pattern to BS 5154, screwed bonnet and renewable trim.
Double check valves	Screwed 15 to 50mm	WRC approved dezincification resistant copper alloy double check valves, for back flow prevention, incorporating two check valve cartridges and a DZR brass test point

		between the two cartridges.
Check valves	Flanged 65 to 300mm	Dezincification resistant copper alloy, swing pattern wafer type check valve.
Strainers	Screwed 15 to 50mm	Dezincification resistant copper alloy, 'Y' type, complete with copper or stainless steel screen.
Strainers	Flanged 65 to 150mm	Dezincification resistant copper alloy 'Y' type, complete with copper or stainless steel screen.
Strainers	Flanged 65 to 200mm	Cast iron, 'Y' type, complete with stainless steel screen, 1.6mm diameter perforations
Piston Type Float operated	15 - 22mm	Copper alloy, screwed to BS21, with copper floats to BS 1968 on hot water cisterns, and plastic floats to BS 2456 on cold water storage cisterns. Diaphragm type to BS 1212 Part 2. Piston type, high pressure, to BS 1212 Part 1, complete with non-return valve.
Equilibrium Float operated	Screwed 25 to 50mm Flanged 65 to 150mm	Copper alloy, double seat balanced equilibrium type, suitable for working pressures up to 10.3 bar gauge. Comprising spindle and head guided with stops to prevent over-travel, adjustable and lockable fulcrum linkage and spun copper float brazed or welded. On feed and expansion applications the long arm type, arranged to close when water level in cistern is at 150mm depth.

2.24.92 Chilled Water Services

Type	Connection Size	Description
Ball valves	Screwed 15 to 50mm	Dezincification resistant, copper alloy, screwed, body and ball, PTFE seat and packing and extended lever.
Filter type ball valves	Screwed 15 to 50mm	A dezincification resistant copper allow body and ball, combined ball valve and fully isolated integral stainless steel strainer, with PTFE seat and packing.
Wedge gate valves	Screwed 15 to 50mm	Dezincification resistant copper alloy, screwed to BS 5154, non-rising stem, screwed bonnet and solid bronze wedge.
	Flanged 65 to 300mm	Cast iron, wheelhead pattern to BS 5150 inside screw, non-rising stem and bronze trim.
Butterfly valves	Wafer type between flanges 65 to 300mm	Cast iron or SG iron semi lugged wafer type generally to BS 5155 EPDM lining, nickel plated disc, lever operated to 300mm size. Use stud bolts and nuts to securely attach the wafer valve to the flange holding back water pressure during maintenance. Padlock valves required for regulation.
	Grooved end 65 to 300mm	Ductile iron grooved end type generally to BS EN 593, EPDM seat, electroless- nickel plated disc, stainless steel stem. (Stem shall be offset from the disc centreline to provide full 360-degree circumferential seating.) Lever or gear operated. Victaulic MasterSeal.
	Grooved end 350-600mm	Ductile iron AGS grooved end type generally to BS EN 593, EPDM seal, PPS (polyphenylene sulphide) coated disc, stainless steel stem. (Stem shall be offset from the disc centreline to provide full 360-degree circumferential seating.) Gear operated. Victaulic AGS- Vic300.
Regulation - variable &/or fixed orifice measuring facilities	15 to 50mm	Regulating disc, double regulating device, set point indicator, rising stem, screwed bonnet, metal to metal or PTFE seat on copper alloy valves, plus outside screw. Copper alloy trim and stainless steel trim on cast steel valves to BS 5154 screwed BS21 To include pressure tappings for flow measurement. Also suitable for ultra low flow measurement.
Check valves	Screwed 15 to 50mm	Dezincification resistant copper alloy, swing pattern to BS 5154, screwed bonnet and metal to metal seat.
	Grooved	Ductile iron, swing pattern to BS EN 12334,

	50 to 150mm	coupled bonnet and stainless steel trim. Victaulic Series 712.
	Flanged 65-300mm	Cast, iron swing pattern to BS 5153, bolted bonnet and bronze trim.
	Grooved 350 to 600mm	Ductile iron, spring-actuated to BS EN 12334, one-piece body and stainless steel trim. Victaulic Series W715.

2.24.93 Regulating

Variable orifice double regulating valves (VODRV) with tappings shall be provided where shown on the tender drawings, whether or not specifically detailed.
Fixed orifice commissioning sets with pressure tappings shall be provided where shown on the tender drawings, whether or not specifically detailed.
Commissioning sets shall be provided on closed systems wherever flow measurement and balancing is required. Sets shall consist of a double regulating valve as described in the appropriate clause above together with a flow measuring station.
Measuring stations up to 50mm diameter shall be manufactured from cast gunmetal to form an orifice, complete with valve controlled test points. The unit shall be provided with screwed ends and shall be pressure rated PN.20. Measuring stations 65mm diameter and larger shall be manufactured with a cast iron body and stainless steel orifice plate. They shall be pressure rated PN.16. The stations shall be suitable for fitting between flanges and be centrally located by the fixing bolts. The units shall be complete with valve controlled test points. Commissioning sets shall be installed to give minimum unobstructed straight lengths of pipe of 10 diameters upstream and 5 diameters downstream, unless otherwise agreed by the CA. Flow charts allowing the manometer readings to be converted into flow rates shall be provided for each size of measuring station.

2.24.94 Domestic Hot Water Return

Auto balancing thermostatic valves shall always allow a trickle flow and not fully close when the set point is reached (to prevent hot water dead legs).

2.24.95 Check Valves

Non return valves shall be of the straight pattern swing or spring-actuated check type. They shall be installed on pump discharges and elsewhere where indicated. Check valves shall be installed in horizontal pipework unless they are specially selected for operation in vertical pipework. They shall be selected to present a low resistance to flow. Valves for pipes up to 50mm diameter shall be manufactured from cast gunmetal or bronze, rated PN.25 and provided with screwed ends. Valves for pipes 65mm diameter and larger shall be manufactured from cast iron, rated PN.16 and provided with flanged ends or ductile iron, rated 2065-kPa, and grooved ends. Where used on systems with operating temperatures in excess of 65°C the disk and seating shall be suitable for the conditions. On domestic services double check valve assemblies shall be provided as required by the Local Water Authority regulations with an intervening drain tap. Double check valve assemblies shall be to the Water Research Council's requirements.

2.24.96 Safety and Pressure Relief Valves

Safety valves shall be of gunmetal or bronze construction with diaphragm protected working parts and PTFE or EPDM to metal seating either Nabic or Bailey Birkett manufacture. All wetted parts are to be manufactured from dezincification resistant materials approved by the Water Research Centre for use on potable water, inlet and outlet connections to be of equal size. Where fitted, lead seals on the setting mechanism shall be intact as supplied by the manufacturer.
To prevent unnecessary operation of the valve, there must be an adequate margin between the set pressure of the safety valve and the normal working pressure of the system. The set pressure shall be at least 10% above the system working pressure, with a minimum margin of 0.7 bar for water and liquid applications, and 0.35bar for steam, air and gas applications. Final selection of the safety valve and its setting will depend on the application and system components selected. The set pressure of a safety valve must NOT exceed the design pressure of the vessel or system being protected.

2.24.97 Installation

Before installation, all inlet pipework should be thoroughly cleaned and blown through to remove any particles or foreign matter. Inlet and outlet pipework should be of sufficient strength to withstand the reaction forces created when the safety valve discharges. It should be installed in such a way that no undue stress or vibration is transmitted to the valve. Protective caps should not be removed from the safety valve until immediately prior to installation. The valve should be mounted vertically with the test level uppermost. The safety valve inlet connection should be attached to the vessel or pipeline using the

shortest length of pipe, with no intervening stop valve. Inlet pipework must have a cross sectional area at least equal to that of the safety valve inlet. Where the pipework is flanged, it must be flat and fitted with a full face joint. For temperature relief valves, the temperature sensing element must be installed in the top 150mm of the heater when installed, with no fouling of the thermal element or restriction of flow.

Discharge pipework shall be as short as possible, with a cross sectional area at least equal to that of the safety valve outlet. It shall be adequately supported and directed to a safe, visible point of discharge. There shall be no flow restriction or isolating valve fitted to the discharge pipework. Any safety valve shall be supplied with a valid pressure test certificate (PED) and letters of conformity from the manufacturer. These shall state the system working pressure, set pressure and date of testing. These certificates shall be plastic laminated and mounted within the plant room. One copy of PED compliance certificates for the new safety valves are to be mounted adjacent to the control panel within the plant room, attached using cable ties, to conduits or similar, or direct to the safety valve itself. Drilling of the boiler house walls to fix safety valve certificates shall not be permitted due to the possible presence of asbestos. A further copy of the PED certificate shall be provided in the O&M manual. All safety valves shall have galvanised steel or copper overflow pipe carried clear of the boiler insulation and turned over to discharge downwards no more than 150mm from the floor.

Keys for padlocks shall be handed over to the Client. On completion of the installation the Contractor shall provide to the Client's insurance company all information on the system expansion vessel as is required under The Pressure Systems Safety Regulations (PSSR).

The Contractor shall obtain from the insurance company a certificate for the installation and this shall be included in the O & M Manual.

A written scheme for working on the vessel(s) shall also be provided in the O & M Manual. Automatic safety valves complying with the appropriate British Standard shall be provided on all boilers and heat exchangers. They shall be set to the latest requirements of the AOTC and sized for the rated output of the appliance.

2.24.98 Pressure Reducing Valve Sets

Also refer to preceding schedules. Pressure reducing valve sets shall be selected to maintain the required downstream pressure under varying inlet pressures. The valves shall provide a tight shut off under no flow conditions.

Valves up to 50mm pipe size shall be manufactured with bronze or gunmetal bodies with ends screwed. Larger sizes shall be manufactured with cast iron bodies with ends flanged. Each valve shall be provided with a safety valve on the low pressure side. The inlet to each pressure reducing valve shall be provided with a strainer complying with the appropriate clause of this section. Pressure reducing valves for water services shall be diaphragm operated. Where there is a significant variation in inlet pressure, a balanced pressure assembly shall be provided. The regulator shall be removable for inspection and maintenance. An enclosed spring pressure relief valve shall be provided on the low pressure side of the reducing valve. The valve shall comply with the safety valve clause herein. Cocks, for the attachment of pressure gauges shall be provided upstream and downstream of each pressure reducing valve set. Isolating valves as described in the Isolation Valves Clause of this section shall be provided upstream and downstream of the set. Drain cocks shall be provided on the high and low pressure side of the valve.

2.24.99 Gas Isolation & Control Valves

Refer also to Section Gas Services.

2.24.100 Strainers

Strainers shall be incorporated in the main circulation of each closed circuit system on the pump suction, on the heating and chilled water branches to each floor level and elsewhere as specified. Up to 50mm diameter strainers shall be bronze or gunmetal screwed 'Y' type.

For 65mm diameter and above strainers shall be flanged cast iron 'Y' type or grooved end ductile iron 'Y' or steel 'T' type.

Strainer screens shall be stainless steel having perforations no greater than 0.8mm diameter but having a total area of not less than twice that of the pipe bore. Flow shall be internal to external through the cage. Baskets shall be capable of withstanding the maximum pressures be applied without distortion.

Isolating valves shall be positioned either side of strainers to enable them to be emptied. Strainers with bolted caps shall be provided with a 15mm drain cock on the cap to permit the strainer to be drained. They shall also be provided with a self sealing pressure test point upstream and downstream of the strainer. On fan coil and air terminal units combined ball valves and strainers may be provided.

2.24.101 Test Points

Temperature and pressure test points shall be provided wherever required to enable satisfactory testing and balancing to be carried out. Test points shall be additional to any permanent thermometers or pressure gauges required.

These points shall, where suitable for the temperature and pressure, be self-sealing insertion type suitable for both temperature and pressure readings. Pressure test points may, alternatively, take the form of, special gauge connections on balancing valves.

2.24.102 Deaerators & Dirt Separators

A combined deaerator and dirt separator shall be provided on each closed circuit system where the maximum operating temperature does not exceed 100°C. Units shall condition circulating water to render it highly absorptive to free and dissolved gases. Particles of dirt, heavier than water shall be removed down to a particle size lower than 10 microns. Units shall be selected for temperature or pressure differential operation as appropriate to the system pressures.

Units shall be horizontally mounted in the main supply pipe at the point of maximum system temperature. They shall have a maximum operating temperature of 130°C and be suitable for a working pressure of 10 bar. Units shall be designed to prevent clogging and to maintain a constant pressure drop across the unit irrespective of the amount of dirt trapped. Water velocities through a standard unit shall not exceed 1.5 m/s. Units for velocities between 1 5m/s and 3m/s shall be specially constructed.

Casings shall be manufactured from mild steel, with an internal mesh manufactured from copper. Connections shall be pipeline size with flanges for sizes 50mm and larger. Smaller sizes shall be provided with screwed connections. A drain valve, capable of permitting dirt removal while the system is operational, shall be provided at the base of each unit. The air release system shall comprise a solid polypropylene float and self closing air release valve. The valve shall be tamper proof and the unit guaranteed against leakage for a minimum of three years. Where particularly specified, a demountable unit shall be provided in which the lower section can be opened and the internals removed for cleaning and inspection.

2.24.103 Pressure Gauges

Dial type pressure gauges shall be black cased Bourdon type. They shall be provided with plain glass front, 150mm diameter white dial with black numbering, black casing with chrome bezel, concentric pointer and red line at the working pressure. They shall be scaled in bars.

The range shall be as required and generally to a maximum of one and a half times the working pressure. The tubes shall be of brass construction and removable, and the outlet screwed.

A 'U' or Scroll type steel siphon and gunmetal cock with insulated handle shall be supplied and fixed for each gauge. On insulated pipes the siphon shall be of such dimensions as to stand clear of the insulation.

In all cases the complete assembly shall be screwed into a socket welded to the pipeline.

2.24.104 Thermometers

Dial thermometers of 100mm diameter, vertical or coaxial, may be of the bimetallic, vapour pressure or fluid expansion types. They shall have black steel cases with chromium plated bezels and the dials and indicating hands shall be protected by a plain glass front. The dials are to be calibrated from 0°C to 120°C for heating installations and 0°C to 30°C for chilled water installations. Thermometers shall have stems angled to ensure that the thermometer dial is vertical and facing in a convenient direction to allow it to be easily read. Thermometer stems shall be provided with brass or stainless steel pockets.

Where thermometers are installed in pipe lines and the diameter of the pipe is too small for the length of the standard bulb the pipe shall be increased to the requisite diameter for a length of 150mm to allow for the proper fitting and insertion of the thermometer well. For boilers stem type and dial type thermometers are to be provided with tails screwed 15mm BSP male. A separate well, threaded 25mm BSP male by 15mm BSP female is to be fitted into the boiler and filled with heat- conducting grease before the insertion of the thermometer. Boiler thermometers are normally to be fitted in a tapping at the front of the boilers, but where the boiler manufacturers do not provide for this the thermometers are to be fitted on the flow mains close to the boilers and in positions where they can be read easily. Strap on contact type gauges will not be accepted. Thermometer and pressure gauges shall be of similar appearance and provided by the same manufacturer.

2.24.105 Altitude/Pressure Gauges

Gauges shall be 100mm diameter, having a brass case with 15mm BSP bottom connection. Gauges are to be calibrated in metres head and bars pressure, the maximum scale range being no greater than three times the standing head of the system. Gauges of excessive scale range will be rejected. The indicating hand is to be black and an additional red hand is to be fitted to the gauge to protect the dial and indicators. A lever handle isolating cock is to be fitted between the gauge and the boiler. Boiler gauges are normally to be fitted to a tapping at the front of the boilers but where manufacturers do not provide for this, gauges are to be fitted on the flow main close to the boilers and in positions where they can be read easily. All gauges are to be of the same type and manufacture throughout.

2.24.106 Urinal Controls

All urinals without exception shall be fitted with infrared optimum flow automatic flushing devices. The Contractor shall ensure that a suitable power supply is provided complete with an accessible unswitched fused connection unit.

All flow devices shall be installed in accordance with the manufacturers instructions and shall be accessible for maintenance and replacement after completion.

2.24.107 HWS Thermostatic Mixing Valves

Refer also to the preceding schedules, Section Domestic Hot & cold Water.

2.24.108 Electrical Continuity

The contractor shall include for electrical continuity of ferrous pipework services in accordance with the requirements of BS 7671.

2.25 Boiler flues

2.25.1 Introduction

Boiler flue systems shall comprise all necessary flue pipes, dampers, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings, Specification and Appendices and tender drawings. Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.25.2 General Design & Installation Requirements

The flue system shall be designed by a specialist flue manufacturer who shall be accredited to BS EN ISO 2002. The installation of the flue shall comply with the manufacturer's installation instructions and be in accordance with the manufacturers drawings. Each flue section and associated fittings shall be designed for assembly on site without alteration or cutting.
Clearance at floors, floor joists and ceilings shall be established by the installation of factory made ceiling supports and firestop spacers.
Flues shall be supported at the recommended centres as provided by the manufacturer of the flue and using brackets and supports recommended by the manufacturer and shall be of approved strength.
Supports shall be capable of supporting four times the combined weight of the flue installation for the maximum heights per support recommended by the manufacturer. Supports shall be strategically placed along the height of the flue to ensure that the maximum allowable compression using a safety factor of 4 is not exceeded upon any component.
The selection of flue sections shall be made so that no joints occur within the depth of any structural element.
Flues passing through any room, other than a roof space or plant room, shall be protected within a 2 hour fire rated structural enclosure, unless stated otherwise.
Offsets shall be made using the manufacturer's 45° elbows. Locking bands must be fitted to all elbows. When the flue serves a domestic appliance having an output of up to 45kW, no part of the flue shall make an angle with the horizontal less than 60°, except where necessary to connect to the flue to the appliance by means of a flue duct, or for external installations where an insulated tee is employed. Locking bands shall be used to secure elbows, or flue sections fitted below ceiling supports. All external flue connections shall be fitted with locking bands or secured with self tapping screws and the complete system shall be gas tight.
Where a flue duct enters a brick or concrete shaft the Contractor shall supply a metal sleeve for building-in. The space between the sleeve and flue duct connection shall be packed with an asbestos free non-combustible packing. The flue duct and sleeve shall have an upward rake and shall finish flush with the inside of the shaft. where a boiler flue duct is required to be connected either to a self-supporting steel flue or to a proprietary type of flexible flue lining, the manner of connecting up together with details of the flue or lining shall be as detailed on the approved installation drawings.
The Contractor shall ensure that horizontal runs are kept to an absolute minimum.
In applications where the flue suction at the appliance exceeds that specified by the manufacturer a draught stabiliser shall be installed. The Contractor shall supply and install a roof support to the flue length where the flue passes through the roof of the building. The Contractor shall supply and install a flashing section, incorporating a storm collar, where the flue passes through the roof. The type of flashing is to be compatible with the roof construction.
Flues which extend 1.5m or higher above a roof level restraining stainless steel tie wires shall be fitted. When tie wires are to be used the Contractor will be responsible for obtaining the Structural Engineers approval for fixing, and for lateral movement loadings. The Contractor shall include for detailing all builders work required in connection with the complete flue installation and obtaining the approval of the Architect and Structural Engineer prior to carrying out the work.

2.25.3 Requirements for Fire Safety

The Contractor shall ensure that there is a minimum of 50mm between all parts of the flue system and any combustible material.
The Contractor shall ensure that all necessary, fire stops, spacers and ceiling supports are used where the flue passes through fire rated floors.
Where flues pass through fire rated compartment walls the Contractor shall ensure that the fire rating of the flue system is rated the same as the fire rating of the compartment through which it passes.

2.25.4 Terminations

Flues shall be terminated one metre above the highest point of the roof, unless detailed otherwise on the tender drawings.
Flue terminals shall limit the penetration of rainwater into the flue system, offer maximum resistance to wind turbulence and also prevent the entry of birds.
Flues for condensing boilers shall be not be fitted terminals, but shall have wire mesh screens to prevent the ingress of debris.
Flues for oil boilers shall be fitted with a "Chinaman's Hat" type terminal.
Flues for conventional gas boilers (pressure jet, atmospheric and water heaters) shall be fitted with a GC1 terminal.

2.25.5 Flues for Condensing Boilers

Flues for condensing boilers shall be a single wall and shall be manufactured using 316 grade stainless steel, that has a bright annealed mirror finish.
The seams of the flue system shall be of fully welded construction and all fittings and joints shall provide a gastight and watertight performance.
The seal on all joints shall be leak proof, have a high temperature seal and be impervious to water and vapour.
The Contractor shall ensure that there are no level sections in the flue system and that all horizontal lengths of flue are installed with sufficient fall to allow all condensate to freely drain. The Contractor shall use 870 and/or 430 bends and tees to facilitate the condensate drainage. Where socket and spigot connections are employed, the socket should always face upwards.

2.25.6 Condensate Drains

a) Condensing boilers

The Contractor shall install a trapped condensate drain from the lowest part of the flue, which shall discharge direct to drain and preferably over a plant room gulley. Where, it is unavoidable and there is more than one low point in the flue system, each low point shall have a trapped drain connection. Traps shall be located where they are not susceptible to freezing. Where this is not possible the Contractor shall insulate the condensate pipework.
Condensate pipework shall be run only in plastic pipework, with minimum falls of 1:20 and where vulnerable to damage shall be protected by an oversized steel pipe.

b) All flue systems other than condensing boilers

Provision shall be made for draining condensation and rainwater from each flue and for sweeping.

2.25.7 Flues for Oil Boilers

Flues for conventional oil fired boilers including; pressure jet boilers, atmospheric boilers, oil fired water heaters etc, shall be twin wall and shall be manufactured using 316 grade stainless steel inner wall and a 304 grade stainless steel outer wall that has a bright annealed mirror finish.
The cavity shall be 25mm. Cavities of 50mm and 75mm may be required, where for example the flue passes through accessible spaces. The cavity shall be insulated with Rockwool with a minimum density of 150 kg/m3 and the ends of all components shall be completely sealed to retain the insulation.
The flue system shall incorporate components that use a snap fitting socket and spigot jointing method to produce a firm and rigid connection.

2.25.8 Flues for Conventional Gas Boilers

Flues for conventional gas boilers including; pressure jet boilers, atmospheric boilers, gas fired water heaters etc, shall be twin wall and shall be manufactured using 304 grade stainless steel inner and outer wall that has a bright annealed mirror finish.
The cavity shall be 25mm. Cavities of 50mm and 75mm may be required, where for example the flue passes through accessible spaces.
The cavity shall be insulated with Rockwool with a minimum density of 150 kg/m3 and the ends of all components shall be completely sealed to retain the insulation. The flue system shall incorporate components that use a snap fitting socket and spigot jointing method to produce a firm and rigid connection.

2.25.9 Flue Dilution Systems

The flue dilution fan shall be of the bifurcated pattern and have a flow switch interlocked with the boilers to prevent the boilers from operating when there is no air flow in the dilution system. The Contractor shall install volume control dampers to control the dilution of air and to balance the system.
The Contractor shall supply and install an air flow proving switch interlocked to the boiler plant, such that the boiler plant can not run without the fan being in operation.
2.25.10 Basic fan dilution guidelines The position of the discharge outlet in relation to the nearest openable window, fan intake and adjacent building shall not be less than the minimum distances stated in the Clean Air Act and BS 6644.
For installations below 1000KW the base of the outlet shall be at least 2 metres from the ground. Local authority approval of the outlet position shall be obtained.
Dampers shall be fitted to enable the system to be balanced. The position of the flue outlet must be chosen so that the diluted products do not accumulate in the vicinity of the terminal. Sheltered positions are to be avoided and louvres shall divert the products away from other air inlet systems and prevent ingress of rain.
Louvres for boiler house ventilation shall be located away from the flue discharge point and preferably on another building face of the boiler house.
The fan unit must be fitted on the discharge side of the system. Inlet and outlet louvers shall be positioned on the same wall to provide a balancing effect against wind pressure. Alternatively, a side wall intake with a vertical discharge may be provided. Outlet louvres shall not be sited in totally enclosed wells or courtyards.
The fan unit shall be fully accessible for regular maintenance.

2.25.11 Condensing Boilers

The ductwork system shall be manufactured using a single skin of 316 grade stainless steel, that has a bright annealed mirror finish, and all seams to be fully welded. The flue dilution fan, attenuators and fittings in general shall all be manufactured form stainless steel. The ductwork system itself shall be installed with falls to condensate collection points, such that condensate does not remain in the ductwork.

2.25.12 Conventional Gas Boilers and Gas Fired Water Heaters

The ductwork system shall be manufactured using a single skin of 304 grade stainless steel, that has a bright annealed mirror finish, and all seams to be fully welded.

2.25.13 Oil Fired Boilers

The ductwork system shall be manufactured using a single skin of 316 grade stainless steel, that has a bright annealed mirror finish, and all seams to be fully welded.

2.25.14 Wiring Electrical Power & Control Wiring

Shall be included by the contractor in accordance with Sections Automatic Controls, Plant wiring & Switchgear.

2.25.15 Fans

Fans shall be protected with a differential pressure switch to isolate the fan output supply in the event of a flue blockage. Fan motors shall be mounted outside of the air stream. The fan shall have a five minute timed delay when stopping operation to allow the flue to purge itself of flue gases.
The Contractor shall supply and install an air flow proving switch interlocked to the boiler plant, such that the boiler plant can not run without the fan being in operation. Electric motors shall meet criteria for listing on the UK Government "Enhanced Capital Allowances, Energy Technology List", and comply with the "Cemep EFF1 efficiency class" (typically motors above 1.1kW).

2.25.16 Wiring

Electrical Power & Control Wiring shall be included by the Contractor in accordance with the section Automatic Controls.

2.25.17 Combustion Test Point

Supply and install a combustion test point in the flue system connection from each boiler in an accessible position.

2.25.18 Flexible Flue Lining

The Contractor shall supply and install a spirally wound corrugated flexible flue liner for all boilers other than condensing boilers, which shall have a smooth internal lining. Flue liners shall be installed in one continuous, unbroken length from terminal to flue system connection.
Where flue liners are installed they shall be manufactured using 316 grade stainless. The top of the flue liner is to be fitted to the flue with an approved sealing plate and intermediate supports are to be fitted as required.
The Contractor shall sweep all existing flues, and provide a certificate to state the flue is satisfactory for use, before installing new flue liners.
The bottom of liner is to terminate with a sealing plate in the builder’s work chamber, into which the boiler flue system and cleaning door is to be fitted.
Provision shall be made for draining condensation and rain water from each flue and for sweeping.

2.26 Ventilation

Ventilation installations shall comprise all necessary ductwork, dampers, automatic control, plant, equipment and accessories to form complete systems in accordance with the construction and manufacturers drawings, Specification, Appendices and tender drawings.
Systems shall include all necessary ductwork, isolating and balancing dampers, grilles and diffusers, automatic control, plant and equipment to form a complete ventilation distribution system in accordance with the approved construction drawings.
The whole of the ventilation and ductwork installation shall be carried out by a HVCA registered ductwork manufacturer, who shall meet with the approval of the Contract Administrator (CA).
Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.26.1 Ductwork

All ductwork shall preferably be manufactured to dimensions taken by the Contractor from site. Shop drawings shall be prepared where necessary by the Contractor prior to commencement of manufacture. Any major deviations from the specified routes and/or duct sizes shall be submitted to the Contract Administrator for approval prior to manufacture.
Where site dimensions cannot be obtained in advance of installation or submission requirements, dimensions shall be obtained from architecture/structural engineering detailed dimensioned drawings. The Sub-Contractor shall make suitable provision to accommodate any discrepancies that may arise between the drawings and site dimensions. Ductwork shall be true to size and accurately lined up.
As far as is practical longitudinal seams and joints in adjacent ductwork sections shall be aligned, particularly where visible from the same general area.
All ductwork shall be constructed and erected to present a rigid installation free from sway, drumming and movement.
Duct sizes indicated on the drawings are clear internal requirement airway dimensions. Allowance shall be made for fire cladding of 100mm thickness to be applied to the completed ductwork systems by others.
Lengths of ducts and other constructional details shall be selected to achieve maximum economy of manufacture and erection, subject to compliance with construction tables and access into the building. Cross-bracing stiffening shall not be permitted. Circular take-offs from main circular ducts shall be conical or as shown on the drawings. Square take-offs will not be permitted.
All intake and discharge openings and louvres shall be fitted with 10mm wire screen in addition to grilles or louvres at such locations. Material used for ductwork construction shall be free from blisters, pits and imperfections in coating. All areas where galvanising has been destroyed (e.g. by welding) shall be cleaned, prepared and painted all edges or sides with zinc-rich paint at works and a further coat shall be applied after erection.
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.
Fire resistant hard inserts/spacers shall be included between ductwork and supports to match insulation thicknesses.
Resilient sheet material shall be inserted between all spacers and supports to reduce transmission of noise and vibration. Drop rod hangers shall be clear of ductwork to allow insulation to be applied freely to ductwork.
Where particularly indicated, allowances shall be made in ductwork construction for instrument and controls connections, and adequate local stiffening shall be incorporated to provide rigid mountings.
The installation of the ductwork must not restrict the 1.00 metre width of defined escape routes.

2.26.2 Ductwork Construction, Materials and Types

Ductwork shall be galvanised steel, composite insulation board (Phenolic foam, foil laminated) or plastic as specified elsewhere. Where plastic ductwork is specified this shall be UPVC and supplied and installed in accordance with HVCA specification DW154.
All galvanised steel ductwork shall be in accordance with HVCA standard DW144 and shall be classed as low velocity unless specified otherwise elsewhere. Ductwork shall be strip cold-reduced sheet continuously hot-dip galvanised to BS EN 10143. grade DX5D+Z coating type Z275.
Longitudinal seams on rectangular ductwork shall be either of the locking type or spot welded suitably cleaned and painted one coat of zinc rich or aluminium paint. Pressure injected sealants shall be applied to all longitudinal seams during manufacture.
Where cut or drilled, exposed edges and surfaces of ductwork and galvanised angles shall be coated with a zinc rich paint such as Galvafroid or equal. Alternatively angles of mild steel may be used. Such angles shall be thoroughly wire brushed to remove all traces of rust and then painted with two coats of "Hammerite" paint or equal.
Branches shall be taken off at no more than 45° angle from the axis of the main duct. Where ductwork is circular consideration shall be given to proprietary systems of spigot and socket fittings incorporating synthetic gaskets. These shall be used where it can be shown that these have economic and constructional advantages to the project. Details of the system shall submitted for approval and acceptance by the CA. Flat oval ducts shall be and circular ductwork may be of spiral wound construction. Where fittings incorporating gaskets are used they shall comply with the requirements of DW/144 and the Building Regulations so far as they are applicable and shall be suitable for the system in which they are installed. Cross joints on circular ducts shall be socket and spigot (duct to duct) with connector as DW/144.
Provision shall be made for dismantling ductwork by means of bolted, flanged joints with gaskets.

Alternatively cross joints on circular ducts may be:
i) "Spiralmate" galvanised circular duct connectors for duct diameter 250mm to 2000mm inclusive, or
ii) "Metu System" galvanised circular flange profile system duct connectors for duct diameter 200mm to 1600mm inclusive, or
iii) "Metu System" type MU duct ferrule (over-collar) joints for duct diameters 71mm to 315mm inclusive.
Flat oval and circular bends shall have internal radii equal to half duct diameter.
Ductwork may be of square, rectangular, circular or flat oval section. The types and sizes shown on the drawings have been selected as the optimum for the volume, pressure drop, velocity and physical constraints of the building. Where economic or constructional advantages to the project exist ductwork may be resized or changed to maximise the use of standard manufactured items or sizes. Any ductwork re-sized for any reason shall maintain equal friction and capacity characteristics of the original.
No changes of size or type will be permitted following acceptance/approval of a fabrication drawing without the written permission of the Architect.
Fire rated ductwork shall be installed where indicated on the drawings and shall be fire rated to achieve the required stability and integrity rating to comply with BS 476 Part 24.

2.26.3 Ductwork Lining

Acoustic linings to ductwork shall be applied where specified elsewhere.

2.26.4 External Ductwork

External ductwork shall be weatherproof and fabricated in accordance with DW144 but with a minimum steel thickness of 1.6mm and be provided with welded seams and flanged joints.
Longitudinal joints shall be avoided but if this is not possible they shall be located on the lower surface. Joints shall be made with stainless steel bolts, nuts and washers or with an alternative material compatible with the ductwork material and resistant to external weather conditions.
The flat top surfaces of all external ductwork shall be constructed with a 10° minimum slope to allow rainwater to drain off.
Ductwork shall be adequately braced to withstand wind and other adverse weather conditions. All supports shall be hot dipped galvanised after fabrication and be supported on concrete slabs or proprietary supports on flat roofs and bolted to rafters in sloping roofs with the roof penetrations properly sealed and capped.
Ductwork to pass through the roof shall be fitted with a suitable weather collar providing an over flashing apron over the upstand kerb.. The collar shall be fixed and sealed to the side of the ductwork.
External ductwork not required to be insulated shall be protected with one coat of primer and two coats of bituminous paint or a two part epoxy based finish. this paint finish shall also be applied to the internal face of ductwork to a depth of 600mm connecting to external louvres. The Contractor shall request confirmation of any particular RAL colour finish before application.

2.26.5 Supports

All ductwork shall be adequately supported from the building structure with supports which shall comply with the requirements of HVCA specification DW 144.
All vertical ductwork shall be supported at each floor level, subject to a maximum spacing of 4.0 metres, using mild steel angle or channel bearers adequately sized to suit the duct dimensions plus insulation and horizontal span involved.
Ductwork supports shall be positioned close to dampers, diffusers and all similar equipment which must not be subjected to distortion, in addition to those hangers and supports required for ductwork generally. Fixings to structural steelwork shall be made using approved beam clamps and then only following the receipt of the Architect's written permission.
Fixings to the soffit of slabs and structural walls may be made with drill anchors of a type approved by the Architect. Shot fired fixings shall not be used without the written permission of the Architect. Threaded drop rods shall be 8 or 10mmØ, depending upon the size of the duct to be supported. Drop rods shall be fitted with washers and locking nuts. Drop rods shall be cut to length in a neat manner and all cut ends, angles and flanges shall be ground to a smooth finish.
Hangers and brackets shall be mild steel and red oxide painted prior to the erection of the ductwork.
Supports shall be so designed as to allow ductwork to be insulated after installation where specified.
Supports for vapour sealed ductwork shall be provided with approved inserts of the same thickness of the insulation material. The inserts shall be of sufficient width to allow for adequate continuity of the vapour seal to be provided. For vertical ducts the vapour seal shall be applied to the insulated duct and made good around the supports to achieve an acceptable level of vapour proofing as DW 144. Where external or in damp location brackets and hangers shall be hot dip galvanised after fabrication.
All hangers shall allow levelling and height adjustment of the ductwork and shall not be attached to ductwork by welding or soldering.
Supports shall be coordinated with other services to avoid clashes. All supports above ceiling access positions, supporting plant and along side ductwork access panels shall be protected against causing injury of any kind to the personnel during and after construction. Where ductwork supports within plant rooms may restrict headroom, they shall be identified accordingly with standard hazard warning tape. Where ductwork is indicated as being fire clad for 1, 2 or 4 hours protection, the ductwork supports shall be of sufficient capacity to cope with an additional load of 30 kg/m2 of duct surface. The supports shall also be positioned to allow 50mm clearance from sides of duct, and be fire rated to the same integrity as the ductwork. Where sheet metal ducts

are to be fire protected for a period of 4 hours the duct section shall be connected by bolted flanges or socket and spigot joints secured with steel (not aluminium) rivets.
All fixings to the structure shall be approved by the Architect and the Structural Engineer according to the following fixing methods:

1) to Concrete - expanding metal in drilled holes of diameter to suit fixing;
2) to Steel – clamped;
3) to Timber - bolted or coach screwed with the fixing in locations;
4) drilling and welding to steelwork will not be permitted without prior written agreement from the Contract Administrator.

Ductwork shall not be permitted to rest on the building structure without prior agreement of the Architect or Structural Engineer.

2.26.6 Access Openings

Access openings and lift-off airtight covers shall be provided in the ductwork for the inspection and servicing of plant and equipment as follows:

1) Fire dampers; - access to be so located as to give access both to the dampers and fusible links.
2) Volume control dampers (motorised and manual): - access to be so located as to give access to blades and linkages.
3) Ducted mounted filters: - access cover to be mounted upstream. Dimensions of access opening to be sized to allow filter elements of the front withdrawal type to be easily removed and replaced.
4) Ducted mounted cooling coils, heater batteries and humidifiers:- access covers to be provided on either side to allow for maintenance and cleaning.
5) Controls and probes: - access cover to be so located as to give access to any duct mounted equipment or apparatus concealed within the duct.
6) Obstructions:- in addition to the items listed in (1) to (5) above, inspection covers shall be provided on either side of any other obstruction not scheduled, e.g., turning vanes, bends etc., and elsewhere as indicated on the drawings and elsewhere where required to facilitate maintenance all in accordance with HVCA Specification DW144 section 20 and shall be as large as practicable to fit on the ductwork.

All access openings shall be rigidly framed, with lift-off airtight covers designed so that they can be speedily removed and refixed with zinc plated progressive cam lock operation quick release tension locks. Multiple set screws and self tapping screws are not acceptable as a method of fixing.
Access openings and lift-off airtight covers shall be provided on all ducts of 150mm diameter and above or ducts having a long side of 150mm or more. In extreme cases flanged removable duct sections are to be provided on the smaller duct sizes.
All ductwork shall be provided with access points to allow internal cleaning in accordance with HVCA guide TR19.
Access openings and lift-off airtight covers to allow internal cleaning of ductwork to be carried out shall be provided as follows:
1) For ductwork less than 600mm x 300mm or 450mm diameter, access openings shall be 450mm x 250mm every 9m. 2) For ductwork in excess, of 600mm x 300mm or 450 diameter access openings shall be 500mm x 350mm every 13m. 3) For small ducts, access openings shall be 300 x 150mm every 7m.
Where any doubt arises with regard to the access requirements for cleaning purposes, the Contractor shall seek the advice of a Specialist ductwork cleaning company to advice as to the position and suitability of the access points to ensure that at a future date all ductwork can be adequately cleaned.
On insulated ducts all lift-off access covers shall be thermally and acoustically insulated constructed with a double skin 0.8mm galvanised mild steel casing enclosing a rock wool infill with a rigid angle sub-frame to allow either flush fixing or surface mounting to the ducting. For safety, every access door shall be provided with a retaining wire linking it permanently to the frame.
All access openings and covers shall be provided with an integral peripheral fire resistant sealing gasket positioned on the door or frame to ensure air tightness to the test methods of HVCA Ductwork Specification DW/144 and Eurovent classes A, B & C.
Hinged access doors shall be provided where indicated on the drawings with openings not larger than 1350mm high by 500mm wide, the doors opening against the air pressure. The hinged access doors shall comprise a double skin steel casing enclosing a rockwool infill with a rigid sub-frame to allow flush fixing to the duct. Both the door and sub-frame shall be suitably reinforced to prevent distortion.
Hinged access doors shall be provided with an integral peripheral fire resistant sealing gasket positioned on the frame together with sufficient clamping type latches to ensure an airtight and weathertight seal between the door and the frame. For safety reasons to prevent personnel being trapped inside the duct the latches shall have operating handles both inside and outside the duct.
A fire resistant sealant shall be provided and inserted between all hinged door and access frames and the duct to which they are attached.
The location of all access/inspection openings shall be co-ordinated with the structure, ceiling grid and other services to ensure that access is unobstructed.

2.26.7 Test Holes

Test holes shall be provided in all main ducts, branches and at major items of air handling plant to allow determination of air

volumes and static pressures generally in accordance with CIBSE Commissioning Code 'A' and shall be provided at the following minimum locations:

1) Fans: - in the straightest section of duct near to each fan outlet.
2) Cooling coils and heater batteries:- both before and after each coil or battery.
3) Filters:- both before and after each filter.
4) Every branch duct and all main runs of duct between every branch take-off.
5) Adjacent to each terminal device or other duct mounted equipment.

The insulation at test hole shall be terminated and omitted locally to enable portable commissioning instruments to be easily inserted into the duct without damage to the insulation. All test holes shall be capped using an approved proprietary system.

2.26.8 Flexible Joints

The material used for flexible joints shall withstand any conditions of temperature, air pressure, noise attenuation and fire resistance specified and shall comply with the standards of air tightness specified for the rest of the ductwork system of which it forms part. Flexible joints shall be fixed to suction and delivery connections of all fans, building expansion joints and other positions where indicated on the drawings. Care shall be taken to maintain alignment between the fan and the duct connection. Flexible joints shall be kept as short as practicable above a minimum effective length of 50mm. In no instance shall a flexible joint exceed 250mm in length.

For flanged rectangular connections, the flexible material shall be held in place with flat bar strips attached to a mating flange as DW144.

For spigot connections on rectangular ducts, the flexible material shall be held in place with flat bar strips as DW144.

Flat bar strips shall be used with proprietary flexible material having sheet metal attached along the edges. Flat bar strips shall not be less than 3mm thick.

Connections to circular and flat air ducts shall be by adapters to provide plain circular ends for spirally round ducts. Alternatively, flanged connections shall be used, as DW144. A fire resistant sealant in accordance with the requirements of DW144 shall be used between the duct and the flexible joint, and the joint secured by clip bands with adjustable screw or toggle fittings.

2.26.9 Flexible Ductwork

To be pre-insulated Unless specified otherwise, provide and fix where indicated on the drawings, "Regaduct - AL" or equivalent aluminium circular flexible ducting pre-insulated with 50mm thick mineral wool flexible mat duct insulation with factory applied reinforced aluminium foil laminate facing vapour barrier.

Where sound absorbing pre-insulated flexible ducts are required, these shall be specified elsewhere.

Flexible ductwork may be used for connecting rigid ductwork to components such as fan coil units, air terminals and header boxes. Flexible ductwork shall not be used for changes in direction between rigid sections and shall be kept to a maximum of 1m unless otherwise stated.

Ductwork shall be compressible flexible and connected via spun cone or square to round transition to and from rectangular ductwork. Metal worm drive clamping band to apply uniform pressure around the entire circumference of the connection to provide an airtight join shall be used.

The duct shall be installed to ensure the inner radius of the bend to be not less than the diameter of the duct and the duct is not compressed flat or substantially changed in its cross section.

The frictional resistance to airflow of the flexible duct shall not exceed 150% of the resistance per unit length of galvanised steel rigid ductwork of equivalent diameter.

Non-metal flexible ducts shall consist of a liner and tear resistant fabric cover bonded together and encapsulating a wire helix between them.

Metallic flexible ducts shall consist of corrugated metal tubing constructed from a multiple layer laminate based on aluminium/polyester/aluminium enclosing and supported by a high tensile continuous steel helix.

Flexible ductwork shall be suspended by bands at not less than one metre centres to prevent sagging and distortion. All ductwork shall be suspended to prevent contact with the ceiling.

All flexible ductwork shall be in full accordance with Local Authority and Fire Officers requirements and shall comply with BS 476 Part 7 Class 1, and be non ignitable, no spread of flame and no smoke development in accordance with the Building Regulations.

2.26.10 Testing

All ductwork systems shall be tested for air leakage in accordance with the requirements of HVCA Specification DW144 unless otherwise stated.

2.26.11 Labelling

All ductwork shall have identification labels in accordance with the Section Identification & Labelling.

2.26.12 Volume Control Dampers

Volume control dampers shall be provided where detailed on the drawings and where otherwise required to ensure correct air balancing of the ductwork system in accordance with CIBSE Commissioning Code 'A'.
Dampers for rectangular ductwork sections and circular of 250mmØ and larger shall be of the opposed multi-leaf type with double skin aerofoil blades constructed to ensure rigidity and prevent distortion or jamming in operation. Blades shall be of aluminium or galvanized steel not less than 0.8mm thick.
Spindles shall be bright steel not less than 10mm diameter. Bearings shall be fully enclosed nylon, sintered bronze or sealed ball bearing. Flanges shall be galvanised steel.
The blades shall have external indication of blade position, whether they are for manual or automatic operation.
Circular ductwork up to 150mmØ may be iris type or double skin streamlined butterfly dampers to the same manufacturing and operational standards for multi-leaf dampers. An access panel shall be provided with on both sides of each damper. The access panel shall large enough to clean the damper blades.
Test points with removable plugs shall be provided both sides of each damper.

2.26.13 Motorised Control Dampers

Motorised control dampers shall be provided where shown on the layout and controls schematic drawings.
Damper actuators shall be supplied by the damper manufacturer according to the requirements of the automatic controls system. Actuators shall be rigidly fixed external from the air steam and be designed to open and close the damper fully without distorting the frame or working loose from its mounting. Spindle lengths shall be suitable to enable the ductwork to insulated as specified without fouling the actuator in any way.
An un-switched fused connection unit shall be fitted locally, but not attached to the respective duct, to serve each 240 Volt actuator.
The damper types shall be as for rectangular and circular ducts in the preceding clause and shall be fitted with solid stop blades having edge & tip seals. Closed damper leakage shall not exceed 2% when tested against a differential air pressure of 1000Pa equally across the face of the damper. The manufacturer shall provide a works pressure test certificate for the damper or type supplied.

2.26.14 Fire Dampers

Supply and install as and when shown fire dampers in the ductwork, in accordance with the Building Regulations to maintain the integrity of the fire compartments. Fire dampers are to be ISO 10294 constructed from stainless steel with galvanised frame for building into the structure and shall be free to expand without distortion, all in accordance with HVCA DW/144 and shall be of the following types:
• folding curtain outside air-stream or
• multi-bladed.
The thermal release mechanism by a fuse link set to operate at a temperature of 72°C ± 4°C and shall be self-latching to allow testing and re-setting of the damper. All dampers shall be tested and rated to the time/temperature curve of BS 476 Part 20 and shall operate in either the vertical or horizontal planes and to close with and without normal airflow conditions.
Supply and install panels to provide access to both the damper and thermal release mechanism. Ensure that access is provided from within the building.
Access panels shall be fitted into matching frames with air tight covers easily removable with quick release fastening. Access shall be provided on both sides of each fire damper to allow for building changes where a single access panel may become inaccessible at a later date after completion.
Where circumstances on site do not allow the fire damper to be fitted within the fire wall or screen, the following methods may be applied with the CA's approval and in accordance with DW TM3:

- the distance between the fire damper and fire rated wall shall be fire clad with an approved material equal to the fire rating of the wall, or
- the fire damper type to be suitable for fitting into circular ductwork up to 520mmØ as ABB Flakt or equivalent. The damper body is to be fitted into an installation frame or direct to the fire rated wall.

Fire dampers requiring to be monitored or combination fire and smoke dampers shall be fitted with the relevant "control mode" as specified elsewhere.

All "control modes" shall provide spring instantaneous closure with visual indication of damper status. Combination fire and smoke dampers shall be of type Smoke/Shield as manufactured by Actionair Equipment Ltd or equal and approved. For all "control modes" the operating controls shall be located outside the duct for testing and resetting of the dampers in accordance with BS 5588: Part 9 & BS 8313. Dampers shall be commissioned generally in accordance with BSRIA Technical Note 6/94 Fire Dampers.

2.26.15 Kitchen Ventilation

Complete systems shall comply with HVCA standard for kitchen ventilation systems DW 172 and as shown on the Tender drawings and detailed elsewhere.

a) Kitchen exhaust ductwork Internal surfaces of ductwork shall be smooth and easy to clean. Spiral wound ductwork not be used. Flexible ducts shall not be used for systems extracting from cooker hoods. Extract ductwork serving cooking extract canopies shall not be fitted with fire dampers.

Ductwork shall be fire clad to comply with the fire resistance of the fire compartments the ductwork is passing through. Grade ductwork to hood or a drain point with a drain and waste. Provide duct access panel at the drain connection to the ductwork. All extract and supply grilles to have removable cores to allow cleaning. Provide access panels as shown on the drawing and if not shown then not less than 3000 centres on the side of the ductwork not less than 40mm above the underside of the duct. All joints should use gaskets with non-porous material impervious to grease and cooking oil. Provide a drain and waste at the base of all risers.

b) Kitchen canopies Supply and install as and where shown on the drawing and as detailed in the Schedule of Kitchen Canopies. The canopy shall be constructed from stainless steel to BS 1449 Part 2 and Grade 304 throughout in accordance with Table 7 DW 171. All seams continuously welded and surface polished after fabrication with perimeter channel on all sides. Provide at least one drain points with trap and screwed drain plug. The surface finish shall be polished flat, smooth and free from weld marks. All joints shall be sealed with an approved sealant.

The canopy shall be inclusive of fresh air make-up and extract. The fresh air make-up shall be discharged into the kitchen area through stainless steel perforated plates along the vertical face(s) of the canopy. The supply and extract air flows shall be as detailed in the equipment schedules.

c) Grease filters Supply and install as and where shown a grease filter of the baffled high efficiency type constructed throughout of stainless steel with drain holes to drainage channel below. The filter shall have not greater than 10Pa pressure drop and shall be secured with clips to retain cells. Filter to be held at 30° to the vertical.

2.26.16 Supply Air Handling Plant

The accumulative air resistance of the internal components shall be added to the specified external resistance. Unless specified otherwise, the contractor shall be assume that the specified external resistance DOES NOT include duct mounted attenuators.

All items of plant and components contained within the frame of air handling units including filters, dampers, heat exchangers, drip trays fans and humidifiers shall be fully accessible to enable regular maintenance cleaning and replacement during the life of the building.

Any other plant, pipework and ductwork serving the air plant or in close proximity thereto must not impede access. Failure to provide full effective access shall be rectified at the contractors expenses before the system is acceptable as complete.

Air plants shall be painted at works when detailed in the equipment schedule. The colour shall be as specified and the paint system shall be a recognised and approved standard applied at works prior to delivery.

Unless indicated otherwise elsewhere, the air plant shall be pre-assembled at the manufacturer's works and demonstrated to the CA that the specified duty of the fan, cooling and heating coils have been met.

2.26.17 Construction

The units shall be manufactured from highly rigid pentapost framework. The units shall be so designed and constructed to provide a fully sealed unit when operating at the specified criterion and test pressures without distortion, damage and be free from drumming. Infill panels shall be constructed from heavy gauge galvanised mild steel not less than 1.2mm thickness and be double skin with 25mm insulated cavities. Panels shall provide airtight seals for positive and negative air pressures developed within the plant by the supply air fan.

All units shall have access to all components with access handles and quick action fastenings. Air tight seals shall be maintained when access panels are locked back into position.

Fans shall be centrifugal forward curved bladed up to 7.5kW motor rating and backward curved bladed above 7.5kW with an efficiency of not less than 78%. The fans shall be double width double inlet type with only the discharge connected the discharge plenum or supply air duct via a flexible duct connector. The fan(s) shall be statically and dynamically balanced and be fitted with suitable anti-vibration mounts on a rigid galvanised steel frame. The motor and fan assembly shall be designed to be withdrawn from the air handling unit.

Drives: should direct or vee-belt, where belt drive is used it shall have not less than two belts and with adjustable mountings and fitted with safety belt guards.

Bearings: shall be sealed ball bearings, with a minimum 40,000 hours life expectancy.

Motors: shall be rating to BS 5000 and shall have slide rail mounting to allow belt tension adjustment. Electric motors shall meet criteria for listing on UK Government "Enhanced Capital Allowances Energy Technology List" and comply with the "Cemep EFF1

efficiency class" (typically motors 1.1kW and above).
Fans: shall have flexible ductwork connection of an approved fabric and shall be watertight where external supports shall be as shown on the drawings and shall have not less than four bracket feet with steel sprung anti vibration mountings with not less than 4mm of static deflection under the weight of unit.
Lighting: Air plants having a cross section a greater overall dimension of 750mm in the depth or height shall include internal lighting to the damper (mixing box), fan and filter chambers. Lighting power supplies shall be served form the local plant room lighting distribution board and not from the MCP (Motor Control Panel).

2.26.18 Inlet and Discharge Louvres

Refer to section Air Terminal Devices.

2.26.19 Intake Casing/Mixing Boxes – Air Handling Units

Supply and install as and when shown on the drawings and detailed in the schedule. Galvanised steel mixing boxes with a thickness not less than 0.8mm. The mixing boxes shall have a rigid steel frame and shall be internally insulated with not less than 20mm Phenolic insulation or 50mm thickness of mineral wool tissue faced fixed with pins and galvanised steel corner angles.

2.26.20 Electric Heater Batteries (also duct mounted)

Electric heater batteries shall comprise sheathed elements and the surface temperature of the element(s) shall not exceed 400°C and the air velocity across the elements shall not exceed 2.5m/s.
Elements shall be held rigidly in a steel frame preventing the heat exchanger from distorting and contained in a galvanised steel casing or within a section of the air handling plant depending upon it's application.
Duct mounted heater units shall be fitted with flanged connections and be fully accessible for removal and replacement.
Access for inspection and cleaning shall be providing on both sides of the heater.
Heaters shall be single or three phase supply as specified elsewhere. Three phase units shall be balanced across the phases.
For fresh air applications the heater shall be designed to raise the incoming fresh air to not more than from -10°C to 5°C and be fitted with a high limit supply air temperature safety lockout control thermostat located downstream of the heater.
Heat outputs shall be controlled proportionally to the varying demand and either stepped in 1kW stages or variable between zero and full load. Heater batteries rated up to 3.00kW shall be always include be suitable for variable control not stepped.

2.26.21 Air filters

Air filters shall comprise primary/pre-filters to Eurovent Grade EU3, and secondary/main filters to Eurovent Grade EU6. Higher grades of air filters shall be supplied when detailed elsewhere.
Dry fabric disposable filters with a dust holding capacity of not less than 0.45 kg/m2 at 125 Pascals. Filters held in frames shall be fully accessible. All other pant, pipework and ductwork must not impede access. Failure to provide full effective access shall be rectified at the contractors expenses.
An inclined manometer shall be fitted across each filter to indicate pressure drop to an accuracy of + or – 25Pa across a range of 0-500Pa. Dirty filter remote indication shall be provided.
The contractor shall fit new filters after satisfactory testing and commissioning and before handover. The contractor shall allow for supplying and fitting replacement filters during the 12 months end of defects period.

2.26.22 Heating Coils

Heating coils shall comprise straight aluminium fins securely bonded to copper tubes construction. Bent or otherwise damaged finned area shall result in the rejection of the coil.
Coils shall be counter flow air to water with a fin spacing not less than 394 fins/metre. Tubes shall have freedom to expand and contract in the frame and casing without damage. Multi-row coils shall be arranged to give a contra-flow pattern with the water flow entering at the leaving air end of the coil. Return bends shall not be located in the air stream but housed within a header section with removable cover.
Automatic air vents shall be provided on the connections and manual air release with isolating valves provided on the coils to ensure the coil will not air lock.
Tapping points to enable water temperature and pressure to be measured on both the inlet and outlet shall be provided.
Coil face dimensions shall be as close as possible to those scheduled and not less than the face area. Face air velocities shall not exceed 3.25m/s and resistance to air flow shall not exceed 100 Pascals.
All coils shall be protected from damage and entry of dirt and water during the course of the contract. Before connecting the coils ensure that the connecting ductwork is clean. Access shall be provided on both sides of the coil for cleaning purposes.

2.26.23 Cooling Coils

Coils shall be designed to allow free flow of condensation to collect in a drip pan strategically located below the coil designed to fall to a low collecting point and shall extend beyond the depth of the coil to allow for a moisture eliminator to be fitted. Drain pans shall be thoroughly cleaned and hot dipped galvanised after manufacture.
Moisture carry-over shall be minimal and the manufacturer shall provide a moisture eliminator on the discharge side of the coil. Face velocities shall not exceed 2.25m/s and the resistance to air flow shall not exceed 125Pa, including eliminators.
Multi-row coils shall be arranged to give a contra-flow pattern with the water flow entering at the leaving air end of the coil. Return bends shall not be located in the air stream but housed within a header section with removable cover and vapour sealed. Drain pipe from the drip pan shall include a trap having a depth to prevent the trapped water being either drawn back into the drain pan, when the coil is on the suction side of the supply fan, or blow out of the trap when the coil is on the discharge side of the fan. As a general guide the column of water to be held in the trap shall be at least 25mm for every 250 Pascals of the fans developed pressure.
Drain pipes shall be copper or plastic and at least 25mm diameter, to be confirmed by the cooling coil manufacturer. They shall terminate over a drainage gulley without causing a trip hazard. Drain and trays shall comply with the requirements of CIBSE Technical Memorandum TM13 and the Health and Safety Document HS(G)70.

2.26.24 Air to Air Plate Heat Exchangers

Air to air plate heat exchangers (recuperators) shall be of the crossflow type constructed from a galvanised mild steel casing housing a profiled heat exchanger manufactured from high quality aluminium and arranged to prevent contamination of the supply and exhaust air flows.
Where specified in the schedules the recuperator section shall be fitted with a face and bypass assembly, suitable for motorised control.
The recuperator section shall be fitted with a sloping drain pan on the exhaust air leaving side with drain outlet.

2.26.25 Unit Performance

The volumetric performance of the Air Handling Unit shall conform to the testing procedure specified in B.S. 848 : Part l : l980. The cooling and heating capacity ratings shall be determined in accordance with B.S. 5l4l :Air heating and Cooling Coils. The air handling unit shall have been tested in accordance with B.S EN 1886 and shall have achieved the following minimum criteria unless otherwise stated in the schedules: Casing Air Leakage: Class “B” Casing Strength: Class “1” Casing Thermal Insulation: Class “T3” Thermal Bridge: Class”TB2” Filter Assembly Leakage: Class “F9”
The air handling unit casing shall have an independently verifiable minimum sound reduction index of;

Frequency(Hz)	63	125	250	500	1k	2k	4k	8k
Reduction(dB)	15	12	22	30	35	32	35	37

2.26.26 Water Side Control Fan Coil Units

Fan coil units shall be of a proprietary manufacture comprising filters, cooling and/or heating coils and fan assemblies, with variable or 3 speed control, and installed where shown on the drawings to meet the performance criteria as detailed in the Equipment Schedules.
The Contractor may offer air side control fan coil units where he considers they may be beneficial to the life of the installation but may not proceed with this alternative without the CA’s agreement. Units shall be horizontal or vertical as required. Air filter and heat exchangers shall be located on the inlet side of the fan and designed to give even air flow across the faces of the filters and heat exchangers.
Performance figures shall be obtained in accordance with BS 4856 and independently certified data and full manufacturers technical details shall be submitted to the CA for comment prior to units are ordered. When appropriate, the CA shall be given the opportunity of inspecting completed fan coil units at the manufacturers works.
Each fan coil unit shall be supplied with a minimum 2 metre length of flexible power cable.

2.26.27 Casing

Casings shall be manufactured from 1.00mm thickness galvanised steel sheets up to 1200mm wide above this unit width the steel thickness shall not be less than 1.20mm. All internal surfaces of the casings shall be fully lined at the manufacturers works and bonded to the casings in such a manner that the air flowing over the material cannot displace the insulation for the life of the fan coil unit. Insulation shall have a fire rating of not less than class “O” and be not less than 15mm thick. The insulation finished surfaces shall be smooth and robust and any mechanical fixings shall not create pockets or reduce the thermal and acoustic integrity of the insulation.
Insulated access covers shall be provided giving full access to the fan, heat exchangers and filters for regular maintenance, cleaning and replacement. They shall be constructed of the same material and finished to match the casings and be designed and constructed in such a manner that they are unable to retain deflections when fitted to the fan coil unit with quick release fastenings.
Access panels shall be sealed to the fan coil unit access opening with suitable gaskets, having a fire rating of not less than class “O” and giving 100% airtightness when fixed in the closed position.

2.26.28 Air filters

Filters shall be the replaceable panel type grade EU3 and held in a lightweight frame without restricting removal.
The performance of the fan coil unit shall designed allow filter pressure drops to increase by 30% without significant reduction in heating and/or cooling output at medium speed.

2.26.29 Heat Exchangers

Finned tube heat exchangers and drain pan construction shall be the same as those for air handling plants but suitable for the smaller fan coil design and capacities.
All coils shall be protected from damage and entry of dirt and water during the course of the contract. Before connecting the coils ensure that the connecting ductwork is clean. Access shall be provided on both sides of the coil for cleaning purposes. Coils shall be fitted with manual air vents and the discharges shall be piped to an agreed position. Automatic air vents may be only be used by prior agreement with the CA.
Condensate drain lines from the drip pan shall be shown on the Contractors drawings and run, at a fall of 1:80 in the direction of flow, to waste in an approved route. Drain lines shall may be plastic and supported to prevent sagging where their installation in service risers and ceiling voids provides protection.

2.26.30 Fans

Fans Shall be direct drive, forward curved, double inlet width centrifugal type with sealed for life bearings.
The fan suction shall be designed to give an even air flow across the face of the heat exchangers. Fan motors shall be totally enclosed, external rotor type with built-in thermistor protection and shall comply with BS 2048 Pt 1, BS 5000 and BS EN 60034. Motors shall be suitable for 240 volts, single phase 50 Hz supply, power factor corrected to a minimum of 0.95 and suitable for speed control.
Each fan shall have its own resiliently mounted motor. The fan and motor shall be statically and dynamically balanced.
Specified room noise levels and thermal duties shall be achieved when the supply fan is running at medium speed.
Where room noise levels are not specified, the measured room noise level shall not exceed NR 35 at 1.00m from the face of the air inlet and outlet grilles when the fan coil unit is running at medium speed. Noise levels shall be measured as part of the commissioning requirements.
2.26.31 Installation

Fan coil units shall be installed strictly in accordance with the manufacturer's instructions. Particular attention shall be given to prevent any transmission of noise or vibration to adjacent services and building structure.
The units shall be installed to give full access for testing, commissioning and maintenance without the need to move or disconnect pipework, ductwork, power supply or move light fittings or any other apparatus. Fan coil units mounted above suspended ceiling or within vertical building service shafts shall be fully accessible. The Contractor shall ensure that his working drawings, submitted for comment, clearly identify the access requirements prior to ceilings or services shafts being constructed.
Coil flow connection shall be fitted with lever operated isolating valves and commissioning sets for low flow conditions shall be fitted on the return connection. A permanent bypass fitted with a lever operated isolating valve shall be installed between the flow and return to allow flushing of the system whilst bypassing the heat exchanger.
Unless specified otherwise in the Equipment Schedules, inlet and outlet plenums shall form part of the fan coil unit but shall not restrict access to the enclosed components. The air inlet shall be a single rectangular duct connection and the discharge plenum shall comprise 3 to 5 no. circular abrupt duct connections giving the installer a variety of simple ductwork distribution arrangements.
A local switched fused connection unit shall be supplied and installed as part of the electrical installation. The Mechanical Contractor shall provide full electrical requirements to the Electrical Contractor at the same time as submitting the drawings to the CA for comment.

2.26.32 Controls

Refer to Section Automatic Controls and the particular requirements given elsewhere.

2.26.33 Commissioning

Refer to Section Testing & Commissioning and the particular requirements given elsewhere.

2.26.34 Fans

Fans shall be statically and dynamically balanced and secures to the motor shaft by a key and keyway to BS 4235.
Fans and drives shall be resiliently mounted within fan casings substantially constructed and designed to support the fan and drive complete without any drumming and/or vibration being transmitted to the connecting ductwork or building structure.

Externally mounted fans shall be protected against corrosion using galvanised steel or zinc sprayed flanges and supports. Other protection of finishing colours shall be as detailed in the Equipment Schedules.
Extract fans shall be supplied with mechanically operated backdraught dampers unless specified otherwise to be duct mounted as part of the ductwork system design.
Supply air fan systems shall be fitted with motorised shut-off dampers to automatically close when the system fan is not running.
The contractor shall allow for supplying 2 sets of replacement sets of replacement drive belts for each belt driven fan supplied and installed within the contract.
Motors shall have maintenance free ball bearings and protected to IP54 against dust and moisture complying with BS EN 60529.
Fan operating status for plant room located fans shall be relayed to the control panel and/or BMS.
Operating status of other fans not located in plant rooms shall be monitored when indicated in the particular requirements given elsewhere.

2.26.35 Performance

The contractor shall be responsible for checking the specified system resistances against his working drawings before orders are placed for the respective fans and plant.
The developed noise levels, in-duct and airborne, shall be checked by the contractor against those specified to ensure that the specified attenuation is adequate to reduce the noise levels to below the specified room background noise levels.
The contractor shall be responsible for issuing the final fan noise data and working drawings of the ductwork system(s) to the attenuator manufacturer in order for him to design the acoustic performance of the attenuators accordingly.
The final air resistance of the attenuators shall be included in the overall system resistance.

2.26.36 Motors and Drives

Motors shall be enclosed complying with BS 5000 & BSEN 60034. They hall be fan cooled to Class 'F' insulation unless operating conditions require a higher classification.
Motors below 1kW rating shall be single phase and larger sizes three phase. Motors shall be provided with thermistor protection.
Where mounted in external air, or in a high moisture laden atmosphere, they shall be weatherproof or separately protected.
The maximum motor synchronous speed shall be 1500rpm and be provided with inverter speed controls. Electrical connections shall be extended to an externally mounted conduit box. Where motors are mounted in the air stream electric wiring shall be extended in galvanised conduit to the fan casing.
Vee-belt drives shall comply with BS 3790. A complete set of replacement belt drives shall be provided by the contractor and hung on the wall of the plant room and labelled accordingly.
Moving parts external to the fan shall be protected with removable guards to comply with BS 5304 and capable of allowing any necessary adjustment.

2.26.37 Centrifugal

Centrifugal fans within plant room locations shall be belt driven unless detailed otherwise elsewhere.
Fans with motor ratings less than 7.5kW shall be forward curved and above this shall be backward curved with an efficiency of not less than 80%. Fans fitted in air handling plants and fan coil units shall be type.
Casing shall be constructed from mild steel or PVC as required and shall be of rigid construction without deflection, drumming or excessive vibration. Fans fitted in central station air handling plants shall include a drain connection with a copper drain line discharging over plant room drainage gully. Fan runners shall be statically and dynamically balanced before despatch. They shall be keyed to bright steel shafts, precision turned and polished.
Fans mounted in fan chambers with free air inlet connectors shall be double width double inlet type and shall be provided with bell mouth inlets. Elsewhere they shall be single inlet, single inlet width type with flanged inlet for ducted connection. All outlets shall be flanged. Fan shall be mounted on suitable frames and bases appropriate to the application. Antivibration mountings shall be included to prevent the transmission of noise or vibration to the ductwork system and building structure.

2.26.38 Axial Flow

Fans shall be long case pattern constructed from hot dipped galvanised to BS 729 heavy gauge mild steel having drilled flanges both ends.
Multi-blade impellers shall be aerofoil design constructed from high density PVC, reinforced glass fibre or die cast aluminium with provision for manual adjustment by the manufacturer.
Fans shall be suitable for horizontal or vertical mounting with purpose made supports with AV mounts and feet.

2.26.39 Mixed Flow

Fan casing shall be manufactured from mild steel sheet to BS 1449 with integral rolled flanges. Bearing support and guide vane

units shall be fitted with mounting studs allowing centralisation of the assembly within the fan casing. Casing and bearing support shall be galvanised after manufacture to BS 729. Casing shall be provided with an inspection panel.

2.26.40 Roof Mounted Extract

All cowls and roof mounting plates are to be moulded from polymeric material and which has a high impact resistance and provide a rigid profile against strong winds and are UV light resistant.
The impeller and motors shall be factory matched, statically and dynamically balanced.

2.26.41 Kitchen Exhaust

Roof mounted type shall be vertical discharge cowl with a motor suitable for kitchen exhaust and directly driven.
The fan shall have a glass fibre cowl or other non-corrosive material of a selected BS or RAL colour. All metal components to be galvanised steel.
Fans to be located internally within plant rooms shall be designed for duct mounting and designed to locate the motor outside of the air stream.
Fan motors and drives shall be fully accessible for maintenance and replacement.

2.26.42 Twin Fan

Where twin toilet extract units are specified, they shall be complete with auto run and standby controls with automatic duty share facility. The fans shall also be capable of running together if required for optimum performance. Each twin unit shall incorporate a back draught shutter to prevent air re-circulation via the standby fan. Each unit shall incorporate full size access panels to both fans to ensure easy access for cleaning and maintenance.

2.26.43 Propeller

Propeller fans shall be mounted in a mild steel ring or diaphragm plate finished in an epoxy coating. Inlet and discharge guards shall be provided where the fan is accessible. Non-return shutters shall be fitted to the discharge of all fans.

2.26.44 Domestic

Through the wall, window or duct mounted extract fans for domestic use shall be of a proprietary manufacture as detailed in the Equipment Schedules. Unless specified otherwise all through window and wall type domestic fans shall be supplied with a speed controller complete with reverse air flow control.

2.26.45 Attenuators

Attenuators shall be supplied and installed where shown on the drawings to meet the performance criteria as detailed in the Equipment Schedules.
Attenuators shall be sheet galvanised steel to HVCA specification DW/144 and the acoustic material shall have fire properties to BS476 Part 7 – Class 1, Building Regulation Class O. Provide facing material in the attenuator fixed to prevent erosion of the material. Attenuators shall have holes drilled for bolting and support shall be by steel frames or brackets fixed to structure, clamp to steel, drilled expanding metal fixings to masonry, screwed to timber or as detailed on the drawing.
Submit the certified results of acoustic performance as insertion loss and general sound power in accordance with BS4718 prior to ordering the works.
Seal open ends after manufacture. Ensure that the attenuator remains sealed until immediately prior to installation. Where necessary store the attenuators in a location protected from weather and damage.

2.26.45 Dust & fume extract systems

Refer to the project particular requirements.

2.26.46 Air terminal devices

Samples of all grilles and diffusers complete with finishes shall be submitted for approval prior to orders being placed. The Contractor will form openings to the location and size shown on the Contractors builders work drawings.
All grilles and diffusers shall be selected to give good air distribution and meet the room operating noise levels given elsewhere.
Grilles and diffusers shall be provided with volume control dampers. All opposed blade dampers, equalising grids, etc. shall be painted matt black to conceal from casual view. The dampers shall be operable by hexagonal wrench or screwdriver through the face of the terminal device.
2.26.47 Manufacture and Construction
Grilles and diffusers, shall be constructed from high quality aluminium sheet and extruded aluminium sections, to BS EN 485 or

BS EN 755 finished as indicated. Heavy duty grilles and louvres shall be constructed from steel Units shall be flanged with mitred corners and secured with secret fasteners or fixings holding them into a purpose made sub-frame. Particular attention shall be paid to mitres to reduce the visual impact of the joint.
Press in spring clip fixings are not acceptable other than for sill or floor mounted grilles and diffusers. Grille or diffuser cones shall be removable where indicated.

2.26.48 Installation

Before commencing the installation the Contractor shall obtain from the Main Contractor copies of all drawings of other services, architectural details and structural drawings. The construction drawings shall not be scaled and the Contractor shall mark up the holes for cutting out on site.
The Contractor shall check the lighting layout and ensure that the ceiling air outlets are aligned with or central between light fittings. Should changes to the drawings be necessary, the Contractor shall notify the Main Contractor and the Contract Administrator and obtain their written instruction.
All outlets, intakes and grilles shall be aligned to be parallel with the building and architectural components and elements align with other outlets and grilles.
Openings for side wall air outlets shall be formed by the Main Contractor in location marked out by the Contractor. Outlets shall be carefully located to align with or be symmetrical with building components.
All outlets and grilles shall be protected from damage and where necessary covered after installation to prevent the entry of duct
The Contractor shall obtain details of and check the type of ceiling to ensure that the outlets and grilles including the header or plenum box behind can be installed taking into account the spacing of primary and secondary ceiling support members, hangers and other services and the like prior to ordering/taking delivery of these. In general all outlets and grilles in walls shall be fitted out after painting is complete and the building is in a clean and weathertight state. However, the order of work shall be subject to agreement with the Main Contractor in order to meet the programme.

2.26.49 Grilles

Grilles and registers for supply air shall have two sets of adjustable blades, one set horizontal and one set vertical. Unless otherwise indicated, the air flow rate controller for supply air registers shall be a damper of the opposed blade multi-leaf type or rhomboidal type.
Grilles and registers for extract air shall have a single set of adjustable blades either horizontal or vertical, or a lattice or egg crate front as indicated. The air flow rate controller for extract air registers shall be a damper of the opposed blade multi-leaf type.
The blades of all grilles and registers shall be adjustable from the front and shall have a friction device to retain set positions. The air flow rate controller of all registers shall be adjustable from the front.

2.26.50 Air transfer grilles (ATG)

Unless stated otherwise, all transfer grille of the chevron non-vision type, comprising two piece to fit the thickness of the door. The grilles shall be of aluminium construction with a border flange with 22mm mitred corners and powder coated finish to a selected BS or RAL colour.
Grilles to be fixed on doors 200mm above floor opening and installed by the Main Contractor. Recess border flange types shall be used where necessary on sliding door.
Air transfer grilles to be fitted in fire doors shall be as detailed elsewhere.

2.26.51 Diffusers

Unless otherwise indicated, each diffuser shall be provided with an air flow rate controller and a means of altering the discharge air flow pattern. All controllers shall be adjustable from the front of the diffuser. Where a diffuser is directly connected to a stub duct which has a straight length of less than two equivalent diameters, an equalising deflector shall be used.
Cone type diffusers shall be provided, where indicated, with finish as indicated.
Linear diffusers shall be of the fixed blade type, or shall include means of independently adjusting the direction of the air jets, as indicated. The method of air volume flow rate control shall be as indicated. Where linear diffusers are mounted in a continuous line, there shall be provision for ensuring alignment between consecutive diffusers and each diffuser shall be provided with means to ensure uniform air flow distribution along the diffuser.
Plenum boxes and duct connections shall be in accordance with manufacturers' recommendations. Circular diffusers, with adjustable air flow pattern, shall have the cone retained by a screwed spindle fitted with upper and lower stop pins or other approved method.

2.26.52 Louvres

Where louvres are to be built in as part of the building works, the Sub-contractor shall ensure that the free-air flow area(s) required are issued to the main contractor as part of his builders work requirements.
Unless scheduled otherwise, all louvres are to be fitted flush with the external structure and are to be flanged.
All air intake and exhaust points shall be protected with louvres designed to prevent ingress of rain. Ductwork immediately behind a vertical 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.
Frames and blades shall be fabricated from galvanised mild steel sections and sheet, or from aluminium alloy of adequate stiffness to prevent vibration and/or damage. All louvres shall be fully protected against corrosion and be provided in the finish indicated. All louvres are to be powder coated to a BS or RAL colour. Galvanised mild steel louvres shall be assembled with non-corrodible bolts. Vermin/bird screens shall be fitted to all external louvres and shall be removable for cleaning. 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.
The contractor shall allow for providing temporary blanking off of all external louvres to allow pressure testing of the building to be undertaken.
2.26.53 Dampers

Damper adjustment mechanisms shall be concealed from casual view, finished matt black, and be operable by hexagonal wrench or screwdriver. For any particular type of grille, register or diffuser provide two sets of tools for setting and adjusting.

2.26.54 Testing and Commissioning

The testing and rating of all grilles and diffusers shall be in accordance with BS 4773:Part 1, Aerodynamic Testing and Part 2, Acoustic Testing.
The Contractor shall measure the air flow from each inlet/outlet in accordance with Section Testing & Commissioning and then carry out all necessary adjustments to obtain the design airflow rates.
When balancing is complete set the airflow pattern from each air outlet by adjusting the blades or baffles to minimise draughts and to obtain satisfactory air circulation.

2.26.55 Ductwork Insulation

Refer to the Section: Thermal Insulation and particular requirements given elsewhere.

2.26.56 Identification and Plant Labels

Refer to Section: Labelling and Identification and particular requirements given elsewhere.

2.26.57 Testing and Commissioning

Refer to Section: Testing and Commissioning a and particular requirements given elsewhere.

2.26.58 O&M Manuals & Record Drawings

Refer to Section: Operating & Maintenance Instruction Manuals and Record Drawings and particular requirements given elsewhere.

2.27 Comfort Cooling / Heat Pump Systems

Comfort cooling installations shall comprise all necessary pipework, isolating and balancing valves, automatic control, plant and equipment to form complete systems in accordance with the construction and manufacturers drawings, Specification and Appendices and tender drawings.
Completed installations being defect-free, tested, balanced and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.27.1 Outline Scope of Works

The fixing of all air conditioning and/or comfort-cooling equipment, installation of all refrigeration pipework and full commissioning shall be carried out by a competent person fully authorised to install the equipment by the relevant manufacturer. A certificate of approval shall be submitted to the Contract Administrator (CA) prior to commencement of the installation.
All air conditioning and/or comfort-cooling systems shall be installed in full accordance with the manufacturers installation instructions.
The Contractor shall allow to make penetrations through roof and walls and make good to surrounding finish on both sides of wall. Sleeve penetrations and pack with insulation, make good wall finish and provide weather proof flashing on external surface over the sleeve.
A piping schematic showing pipe lengths, sizes, heights, difference between units, trap locations, refrigeration charges etc. shall be approved by the Equipment Supplier prior to installation and starting up, then submit a copy of the complete scheme to the CA. The equipment supplier (or his approved representative) shall inspect the complete refrigeration installation for each system to ensure that it is satisfactory for the operation of their equipment prior to start up.

2.27.2 The Fluorinated Greenhouse Gases Regulations 2008

Unless stated otherwise, it shall be deemed that cooling and/or heat pump systems included within the scope of works, will contain more than 3kg of man made fluorinated ('F') refrigerant gas and the Contractor shall comply with these regulations. The Contractor shall be responsible for carrying out leakage tests and keeping a record of these tests using the sample record sheet contained within the Appendices in accordance with these regulations during the 12 months defects liability period.

2.27.3 Chilled Water Systems - Air Cooled Water Chillers

Packaged chillers shall be selected to achieve the cooling duty necessary to satisfy the design requirements when operating under the peak ambient temperature conditions as given elsewhere and shall comply with BS7120.
Rotating and reciprocating components shall be dynamically balanced. All components shall be readily accessible. Each machine shall be provided as a fully packaged, factory assembled and tested unit, constructed on a robust galvanised steel frame and casing. No refrigerant comprising or containing any CFC shall be used. Where available, preference shall be given to the use of refrigerants which do not comprise or contain HCFCs. Chillers shall be factory finished with a baked on enamel or electrostatically sprayed coating. Internal units shall be to the manufacturer's standard colour. Externally mounted units shall be finished to a BS or RAL colour as given in the Equipment Schedules.

2.27.4 Compressors

Compressors shall be suction-gas cooled, hermetic, scroll design. All moving parts shall be statically and dynamically balanced. Crankcase heaters shall be provided for extra protection against liquid migration.

2.27.5 Cooler

Cooler shall be fitted with a thermostatically controlled heater for protection against freezing down to -15C ambient. The cooler shall be insulated with 19mm closed cell foam insulation having a Class '0' fire rating. The pipework installation shall be so installed as to allow drainage and venting of the heat exchanger. Water connections shall be either PN10 flanged or grooved and compatible with Victaulic connections.
A 40 mesh water strainer shall be fitted in the pipework system upstream of the heat exchanger to prevent clogging.

2.27.6 Condenser Coils

Seamless fin and tube coils with high condensing coefficient and corrosion resistant copper tubes shall be arranged in staggered rows, mechanically expanded into aluminium fins.
Fans: Condenser fans shall be corrosion resistant and designed for low noise generation. The fans shall be designed for maximum efficiency and be statically and dynamically balanced for vibration free operation. Each fan shall be fitted with independent motors and positioned for vertical discharge. Fan guards shall be heavy gauge, rust resistant PVC coated steel wire.

Motors: Shall be totally enclosed air over squirrel cage type, current protected and sealed for life.

2.27.7 Pipework, Valves & Accessories

Refer also to section - Pipework, Valves & Accessories.

2.27.8 Application

For chilled water and condenser cooling water having maximum working pressure 6 bar gauge and temperature 5°C to 35°C. Valves and fittings shall be metric standard to a pressure/temperature rating of PN10 minimum for ferrous valves and PN16 series 'B' minimum for copper alloy valves.

2.27.9 Direct Expansion Refrigerant Systems

Single piece packaged air conditioning units
These shall be self-contained factory assembled package unit suitable for the environment in which it will be located. The supply air fan shall be centrifugal with anti vibration mountings and static and dynamic balanced.
Air filters shall be dry fabric washable or recyclable throwaway type to EU5 as a minimum. Filters shall be clean at handover and the contractor shall allow for cleaning or replacing the filters during the 12 month warranty. The Compressor shall be reciprocating or rotary with anti vibration mounting. Cooling coils are to be copper tubes with aluminium fins. Condensing coils shall be suitable for the environment in which they are operating. Coated coils shall be used in coastal regions or high saline environments.
The condensate tray shall collect all condensate and shall have drain connection with trap. The heating coil shall be copper tubes with aluminium fins
Condenser fans shall be propeller type with motor suitable for external conditions. The controls shall comprise high-pressure refrigerant, low-pressure refrigerant, oil pressure cut off and cycling delay timer – to prevent short cycling.
The unit shall include liquid line sight glass with moisture indicator, filter drier and liquid line solenoid valves. All expansion valves/devices shall be included and the unit shall have a full refrigerant charge. The piping shall be evacuated, charged and tested in the factory. The unit shall be completely factory wired and provided with all circuit breakers, fuses, and starters. Provide isolating switch.
Provide two (2) galvanised mesh channels with anti vibration mountings between the unit and the channels to mount the unit.

2.27.10 Split Package Air Conditioning Units

Condensing coil/outdoor coil shall be copper tubes with aluminium fins and propeller driven fans. Condensing coils shall be suitable for the environment in which they are operating. Coated coils shall be used in coastal regions or high saline environments. The units shall have a suction accumulator and crank case heater with high pressure cut out and HP and LP switches (HP manual reset) with non-cycling timer to prevent excessive frequency of starting. All other equipment necessary for automatic unattended operation shall be supplied and fitted by the manufacturer. Provide all controls, starters, fuses or miniature circuit breakers for the equipment. All electrical equipment shall be mounted within the unit in a separate enclosure. All wiring, electrical equipment their connections, bonding, isolators and automatic controls shall be supplied and installed strictly in accordance with BS 7671.
Air filters for fan coil units shall be dry fabric washable or recyclable throwaway type to EU5 as a minimum. Filters shall be clean at handover and the contractor shall allow for cleaning or replacing the filters during the 12 month warranty.

2.27.11 Refrigerant Pipework and Installation

Supply, install, test and commission all interconnecting refrigeration pipework between the outdoor and the indoor unit(s). All pipework shall be carried out in refrigeration quality soft/medium drawn copper tubing to BS2871 Part 2: 1972 complete with the appropriate joint pipes for twin and triple systems.
All pipework shall be installed by an approved refrigeration engineer and in accordance with BSEN 378 2000.
Refrigeration pipework joints in copper pipework shall be brazed. Brazing shall be carried out to the requirements of the HVCA Code of Practice – Brazing and Bronze Welding of Copper Pipe and Sheet.
Dry nitrogen shall be bled continuously through the pipework at minimal pressure during brazing or soldering to eliminate oxidation. Brazing shall be carried by operatives having passed approval examinations in accordance with that standard. Joints shall be kept to the absolute minimum. Flared or screwed joints shall only be used with the CA's permission. Fittings shall be integral ring solder fittings or shall comprise brass or bronze brazing fittings.
Appropriate refrigeration installation tools shall be used at all times.
The longest possible lengths of copper pipe should be utilised to minimise the number of joints. Formed bends shall be used in preference to fittings.
All bends to be long radius. All connections to equipment and fittings shall be made with compression fittings, bolted connections or other approved in an accessible position to allow removal. All pipework is to be properly fixed and supported using galvanised trays. All pipework shall be labelled with the condensing unit reference number at 3 metre intervals.
Refrigerant pipework shall be adequately supported with maximum support spacings as given in the relevent section.

Where the pipework cannot be adequately supported at these spacings directly from the building structure, continuous proprietary channel, angle or tray support systems shall be provided. Pipework shall be supported by sheradized steel clips with a rubber or plastic sleeve to prevent chafing or vibration. The arrangement or pipework and support shall be agreed with the CA before installation.
Where the vertical rise exceed 3 metres, an oil trap shall be formed in the suction line at the base of the riser and at 3 metre intervals throughout the length of the riser, or at such intervals as are recommended by the refrigerant plant manufacturer. Horizontal lines shall slope downwards in the direction of flow.
All support brackets external to the building and subject to moisture or those installed under floor spaces shall be hot dipped galvanised after fabrication. All brackets shall be rigid bolted type with a plastic liner. Where pipework and insulation is installed externally it shall be painted with an approved weather resistant coating.
Where pipework and insulation is fitted in coastal areas and or areas prone to seagulls, it shall be protected from damage by suitable upturned galvanised tray.

2.27.12 Pressure Testing

All pressure testing shall be carried out in strict accordance with the pressure vessel regulations. After installation of pipework, and prior to sealing of insulation joints and equipment starting, the pipework shall be checked for leaks with a halide torch and/or electronic leak detector.
The installation shall then be pressure strength tested to 42 bar, checked for deformation. The pipework shall then be leak tested at 33 bar and held at this pressure for 24 hours after which time it shall be re-checked for leaks.
If the test pressure has fallen, re-check the installation and repeat the test procedure until pressure is held for this given time.
HSE document GS4 should be followed during the pressure testing operation.

2.27.13 Evacuation and Dehydration

Following the successful pressure testing, the pipework shall then be vacuumed/dehydrated to (- 752mm Hg) 2 torr, and held at this setting for a minimum period of 12 hours. A triple vacuum technique shall be used unless otherwise directed.

2.27.14 Refrigerants - Charging

The refrigerant charge weight must be accurately calculated to the actual installed length of pipework in accordance with the manufacturers recommendations. Charging shall be carried out by using an appropriate charging station:

- ➢ Firstly, partially charge the system with inert gas.
- ➢ Provide a gauge and filter on the connection from the container to the charging valve. These will remain the property of the Contractor.
- ➢ Start up the compressor.
- ➢ Fully charge the system to the calculated amount by observing the sight glass.
- ➢ Raise the discharge pressure to maximum value and add more refrigerant if necessary.
- ➢ Check the amount of refrigerant added coincides with the amount calculated.
- ➢ Add additional lubricating oil as required.

2.27.15 Certification

The contractor shall be responsible for confirming to the CA the volume of refrigerant used when the system(s) are fully charged.
The contractor shall include for testing the refrigerant systems during the warranty period according their charge volumes and issuing compliance certificates to the Building Manager for inclusion in the Log Book. In accordance with clause Maintenance, Servicing & Certification under the Warranty Period.

2.27.16 Controls and Wiring

Unless stated otherwise, all packaged air cooled water chillers, and DX air conditioning systems shall incorporate their own integral automatic controls.
All controls wiring for split system and single piece packaged air conditioning systems shall be carried out by the Contractor. The power wiring to external condensers shall be supplied and installed by the Electrical Sub-contractor according the power requirements provided by the CA.
Power and controls wiring to packaged air cooled chillers shall be supplied and installed by the Contractor.
The controls system for each unit shall be linked back to a main control panel or BMS to provide status indication and timed stop/start etc..
Refer to the Section Automatic Controls, Plant wiring & Switchgear and the particular requirements given elsewhere.

2.27.17 Condensate Drains

Condensate drains shall be installed from each cooling unit, for air, water or direct expansion refrigerant cooling systems and

plant. The condensate pipework shall run in suitable polybutylene (PB) plastic pipe. The condensate pipework shall not be less than 25mm in diameter unless indicated otherwise or designed/recommended by the cooling equipment manufacturer. Condensate pipework shall be adequately supported to prevent sagging and shall not be incorporated onto electrical cable trays carrying cables.

Pipework shall be run at a minimum fall of 1:80. The use of in line condensate pumps (except unit inclusive lift pumps) shall be avoided wherever possible. Where it is not possible to discharge condensate drains to a suitable point without the use of in line condensate pumps, prior approval shall be sought from the CA before commencement.

All condensate drains (from both indoor and outdoor units) shall be run to terminate at a suitable foul drain. Condensate waste shall be connected to the foul drain via a deep seal (or waterless) trap. Careful consideration should be given to the discharge location of all condensate drainage into foul drains so as to prevent the trap drying out. Where possible the drainage connection shall be made to a local wash hand basin waste outlet prior to its own trap.

Written approval from the Local Water Authority must be obtained prior to connecting the waste to the surface water drainage system. If Water Authority approval is granted, the condensate drainage shall run to discharge in a safe manner so as to avoid creating a slip/freeze hazard and shall not damage the building fabric or its surroundings.

2.27.18 Noise Levels

Performance noise levels shall be in accordance with the CIBSE Guidelines or as given elsewhere and shall not be exceeded or as given below, whichever is the onerous-:

- Conference rooms NR30-35
- Non-conference habitable rooms NR35-40
- Plant rooms NR50 within 1.00m of the external doors
- or NR35-40 where the plant room has an internal access door.
- External plant <NR55 @ 1.00m from source

2.27.19 Refrigerant Leakage Detection

Plant rooms, habitable equipment rooms in which chillers, heat pumps and refrigerant pipework are contained or pass through shall be fitted with suitable and approved gas leakage units.

The units shall be linked either to the building management system or fire alarm control panel to give an audible and visual alarm indicating which detector or zone has been energised. When connected to the central mechanical control panel or BMS, an alarm shall activate the common alarm relayed to the caretaker or building facility manager or other agreed building manager.

Detectors shall be wall mounted and shall alarm concentrations of refrigerant in excess of 500ppm. Where required units shall be located within equipment or provided with a remote sensor for location within equipment.

2.27.20 Electrical Cabling Distribution

Power and control wiring distribution shall be installed strictly in accordance with BS7676 and Section Automatic controls, Switchgear and Wiring.

2.27.21 Pipework Insulation

Refer to the Section Thermal Insulation.

2.27.22 Identification and Plant Labels

Refer to Section Labelling and Identification.

2.27.23 Testing and Commissioning

Refer to Section Testing and Commissioning and as detailed elsewhere.

2.27.24 O&M Manuals & Record Drawings

Refer to Section Operating & Maintenance Instruction Manuals and Record Drawings and the Particular Specification.

2.28 Automatic Controls, Switchgear & Wiring

2.28.1 Introduction

Automatic controls, switchgear & wiring installations systems shall comprise all necessary containment, plant, equipment and accessories to form complete systems in accordance with the construction and manufacturers drawings, Specification, Appendices and tender drawings.

The application of the automatic controls and the programming of the DDC and/or BMS systems shall be designed by the automatic controls specialist to meet the performance requirements given in the project's particular requirements. Completed installations being defect-free, tested and commissioned together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.28.2 Control Panels

This section applies to all electrical control panels for mechanical plant, whether part of proprietary packaged plant, or whether built specially to house motor starters and controls.

Design, construct and install all control panels and associated switchgear so that their operation and maintenance can comply with the Electricity (Factories Act) Special Regulations 1908 and 1944; the Health and Safety etc. Act 1974, the Electricity at Work Regulations 1989 and subsequent revisions to the legislation, together with other safety legislation and regulations current on the date the equipment is ordered.

Supply & install the control panels and all interconnected equipment to form a complete and working system. Co-ordinate the designs of all interconnected units, their wiring and terminal connections so that they are mutually compatible and function as a whole in accordance with the design intent. Ensure that the cable access systems required are adequately sized, supported and spatially co-ordinated with other equipment and the building structure.

Ensure that all cable terminals are big enough to take the sizes of cables specified. Ensure there is ample space within panels, isolators, etc. to accept the cables specified. Prepare schematic, wiring and general arrangement drawings of the Control Panels and all equipment connected and submit the drawings to the CA for comment at least four weeks before manufacture is required to begin. Include details of the motor drives finally ordered. The drawings shall be A4 size at least. Design and manufacture all purpose-built assemblies such as those incorporating motor control gear and associated equipment and components to comply with the standards referred to in this section and with the component manufacturers' recommendations. Protect equipment against physical damage and from ingress of water, dust and other contaminants during delivery, storage and installation.

2.28.3 Control Panels Construction

Construct the Control Panels with rigid framed enclosures and with panels in zinc coated mild steel at least 1.6mm thick for panels up to 600mm x 600mm and at least 2mm thick for larger panels. Round all edges and corners to a minimum radius of 3mm. All finished surfaces, both internal and external, shall be protected with a wear resistant satin white paint system unless indicated otherwise elsewhere. Provide details of the proposed panel construction and paint system with the drawings submitted to the CA for comment

Design and construct the panels with protection to IP54 and design the panels for continuous operation. Construct the panels of ample size and/or provide ventilation to maintain all internal components within their maker's specified temperature limits with a plant room temperature up to 40°C.

Mount proprietary equipment such as Inverters and Motor Soft Starters in accordance with their makers' recommendations. Ensure that heat generated can be safely dissipated. Where these are to be mounted outside the control panel, their protection shall be to IP54 and the Contractor shall obtain the CA's agreement for mounting externally to the control panel. Where control panels contain Inverters or Motor Soft Starters, air temperature detectors shall be fitted to warn when the panel limiting temperature is reached.

For panels weighing more than 40 Kg provide 4-no removable lifting eye bolts on the top of each panel. Provide blanking plugs to seal the holes when the lifting eyes are removed. Assemble floor- mounted units on a plinth at least 100mm deep made of channel iron or zinc-coated sheet steel, with holes provided to bolt the complete assembly to the floor. The maximum height of floor- standing units shall be 2m above the plinth. Notwithstanding clause 3000, ensure that the panel dimensions, particularly the height, do not prevent proper installation of the panel and of the cables and cable access systems associated with it. Do not mount any live panel components on the floor, roof or sides of the panel, or less than 150mm from the bottom of the panel.

Provide panel doors with lockable hand-operated fastenings.

For panels mounted externally fit appropriately rated anti-condensation heaters which are automatically energised when the panel is switched off to automatically prevent the internal temperature falling below to 10°C.

2.28.4 Wardrobe-Type Control Panels

Construct Wardrobe-Type Control Panels as type tested assemblies to B.S. EN 60439-1 with minimum internal sub-division to Form 2 Type 2.
Mount all main components on a back plate with switches and indicator lights on the doors. All live parts are to be efficiently shrouded against accidental contact during maintenance or inspection. Supply power to all motor drives and packaged plant via fuses to B.S. 88 or circuit breakers to BB(EN) 60898. Loosely loom all internal wiring in slotted metal or plastic trunking. Size all wiring to be protected against both overload and short circuits by the fuses installed. It shall however be possible to apply a suitable clip-on ammeter to motor supply cables for commissioning purposes without taking off covers or disturbing the wiring. Incorporate extra space in the panels for terminals, fuseways and starters up to one quarter of the installed capacity.

2.28.5 Compartmented Control Panels

Construct Compartmented Control Panels as type tested assemblies to B.S. EN 60439-1 with minimum internal sub-division. Equip each compartment with the following equipment and controls as appropriate:

- Fuse/switch isolator.
- Ammeter for motor drives 7.5kW and above.
- Control switches and indicator lamps.
- Motor starters.
- Separate protection for the low speed windings of motors with separate windings.
- Door lock.
- Labels and warning notices.
- Separate control circuit breaker/fuse.

Ensure that it is possible to measure motor current safely for commissioning purposes with a suitable clip-on ammeter. Incorporate spare compartments within the panels up to one quarter of the number and capacity fully installed. Equip the spare compartments with switch/fuses sized for each compartment's maximum capacity. Provide a distribution of spare compartment sizes to match that of the installed drives and packaged plant.

2.28.6 Control Panels – Electrical Requirements

Motor control panels and their internal assemblies shall be Type Tested to B.S. EN 60439-1. Provide copies of Type Test certificates when submitting drawings to the CA for comment. Design the internal busbar system, including its fixings within the assembled panel, to carry the full load current.
Design all equipment and wiring for 50Hz electrical supplies of 400V (3 ph) or 230V (1 ph) plus 10% or minus 6%.
Design and construct all electrical equipment to be suitable for use in local ambient temperatures up to 40°C and with relative humidities up to 90% with occasional occurrences of moderate condensation. Proof all equipment against moderate amounts of dust and corrosion by salt laden air where specified. Use only materials resistant to mould growth and attack by vermin.
Gland cable and conduit entries to maintain the IP54 protection specified. Where light cables need to enter the panel via trunking, provide a purpose made watertight upstand at least 75mm high to form a water resistant junction between the panel and the cable trunking. Terminate all incoming and outgoing cables in terminal blocks close the cable entry positions.
Ensure that all internal cableways and terminal blocks are sized to accept the input and output cables specified.
Shroud all cable terminals, live parts of the switchgear and other components, including live parts to the rear of switchgear, against accidental direct contact when testing and inspecting the panel.
Install fuses either as part of fuse/switches or in shrouded fuse holders. Identify and mark all cables, cable terminals, fuses, switchgear and other components with permanent labels using the circuit references used in the as-fitted/record drawings.

2.28.7 Cartridge Fuses

Cartridge fuses shall comply with B.S. 88 and shall protect all cables serving sub-circuits, packaged plant and motor drives against both overload and short circuit faults. Select fuses for protecting motor circuits to suit the motors finally installed according to the fuse manufacturer's recommendations and taking account of the form of motor starting employed.
Ensure all fuses installed in the motor control panel provide satisfactory discrimination with sub- circuit fuses within the panel and with the panel's main supply fuse. Ensure all contactor/fuse combinations provide Class 'C' Co-ordination as defined in B.S. EN 60947-1.

2.28.8 Moulded Case Circuit Breakers

Moulded case circuit breakers shall comply with BS EN60947-2.
Circuit breakers shall have an over-centre trip free toggle action operating mechanism, with a quick make, quick break action and positive hand indication. A heavy duty cross bar shall link across all poles to ensure common tripping.
The trip unit shall contain thermal and magnetic trip elements on each pole, and assume a centre position when the circuit breaker is tripped. The handle shall not allow false indication, and shall comply with BS EN60947-3 for contact separation and use as a means of isolation.
Resetting shall be by moving the handle to 'Off' and back to the 'On' position again. For circuit breaker of frame ratings greater than 400 amps a push button shall be provided on the front, for mechanically tripping the circuit breaker.

2.28.9 Miniature Circuit Breakers

Miniature circuit breakers shall comply with BS EN60898. They shall be of the thermal/magnetic current limiting type, providing both over current and short circuit protection.
Miniature circuit breakers shall be type C or D unless indicated otherwise elsewhere, with an interrupting capacity of at least 10kA at 230/400 volts calibrated at an ambient temperature of 40°C.
When a short circuit or overload occurs the breaker handle shall move to the 'Off' position, automatically reset, but requiring the handle to be moved to the 'On' position before the circuit can be restored. The handle shall be of the trip free type so that if the device is closed onto a fault, tripping will occur irrespective of the position in which the handle is held.
Where additional protection is required against 'Direct' and 'Indirect Contact', residual current devices which comply with BSEN61008-1 shall be provided. These shall take the form of combined over current/residual current protection devices (RCCB) with a rated residual tripping current as indicated on the tender drawings.

2.28.10 Contactors

All contactors shall be made in accordance with BSEN60947-4-1 for uninterrupted rating, mechanical duty Class I and making and breaking capacity category A4 or D4 for AC and DC circuits respectively, with fused coil circuits unless otherwise specified.
All contactors shall be supplied for the current rating specified. Where applicable, contactors shall be fitted with arc shield and magnetic blow outs. Contacts shall be easily renewable and of the self-cleaning type. The design shall be such as to prevent welding-in.

2.28.11 Motor Starters

Motors starters up to 7.5kW shall be direct on line starting incorporating an air break type magnetically operated contactor to connect the motor to the mains Starters shall be provided with thermally operated adjustable trips in each phase.
Starters to be included in heating and ventilation systems shall have on/off push buttons or arranged for pilot wire control as detailed on the drawings. Starters for Pilot wire control shall be without no volt trip and fitted with manual reset overload. Motors exceeding 7.5kW rating shall be star-delta type of the air break automatic type incorporating magnetically operated contactors to change motor connection from star to delta by means of a time delay mechanism, adjustable between 3 and 20 seconds. Thermally operated adjustable trips shall be installed in each phase. All thermal overloads shall be of a rating to match the motor current and shall be adjusted to trip on 100% of motor nameplate rating.

2.28.12 Control Circuits

Design control circuits for contactors to operate at 24v AC. Provide control circuit wiring of at least 1.5mm2 or a ring circuit of 0.75mm2 and sized so that voltage drop even during motor starting is never great enough to prevent correct operation of all devices served.

2.28.13 Control Relays

Install control relays of the plug-in type conforming with B.S. 800 and B.S. 5992, with suitably rated contacts for the circuits to be controlled.
Control relays to have inbuilt dust proof covers.

2.28.14 Lamps

Indication lamps shall be of the following colours and be of the long life LED cluster display (mixing of lamp types in a panel will not be allowed): RUN/ENABLED Green Lamp TRIPPED/ALARM Red Lamp FLOW/INDICATION Orange lamp PANEL LIVE (Each section) White Lamp SUPPLY ON (Packaged plant) White Lamp
Install indicator lights of the extra low voltage (12 or 24 volt) type and a common push-to-test facility shall be fitted. Lamps shall be replaceable without the use of special tools.

2.28.15 Monitoring Instrumentation

Meters shall be fitted on the front fascia of the control panel at a mounted height of between 900 and 1200mm above the finished floor level, unless stated otherwise. Meters shall be capable of passing starting currents without damage.

2.28.16 Panels Labels

Information and Warnings Screw-fixed permanent engraved labels to all panels to provide information and warning to suitably qualified persons carrying out operation and maintenance: a) A label indicating the function of each switch and lamp indication. b) A label on each openable panel door reading: "WARNING - ISOLATE PANEL BEFORE MAINTENANCE". In addition, a self adhesive warning label is to be fixed to each door giving access to 400 volt circuits. c) A key diagram showing the source and identification of all power supplies entering a panel, their function and means of isolation.
The Contractor shall submit panel fascia layout drawings and a sample of the control panel labels to the CA for agreement prior to manufacture of control panels.

2.28.17 Panel Earthing

Either install an earthing bar of 25 x 3mm copper along the whole length of each panel or provide individual earth terminals adjacent to each power supply, bonded to the backplate. Connect each panel section, including the panel doors and each cable earth continuity conductor to earth studs specifically designed for the purpose via connections sized to comply with B.S.7671.

2.28.18 Panel Isolation

Route the incoming supply via a separate full-load rated four pole isolator mounted so that it can be operated with the panel doors open or closed.
Power supplies serving building management systems shall be separately protected, or served from a separate secure supply.

2.28.19 Panel Mounted Switches

The following shall be the minimum requirement unless indicated otherwise elsewhere:- a) Single speed, single motor drives: HAND/OFF/AUTO. b) Two-speed motor drives: HIGH SPEED/LOW SPEED and HAND/OFF/AUTO c) Motor drives with Duty 1 and Duty 2 motors: DUTY 1/DUTY 2 selector switch for use when the motors are in HAND control and with HAND/OFF/AUTO selector switches for each drive. If the BMS system automatically rotates motor duty provide 2 hand/off/auto selector switches. d) Three position rotary switch:- Position 1: Winter Both heating and hot water systems will operate under control and within the programmed timed parameters Position 2: Summer Hot water only will operate under control and within the programmed timed parameters but heating frost protection retained Position 3 Holiday & Frost All plant off and heating frost protection retained e) Push button facility for each heating zone to provide extended run times to suit the user's requirements. f) Push button facility for each hot water zone to provide extended run times to suit the user's requirements. g) Push button facility for each ventilation zone to provide extended run times to suit the user's requirements.
Each item of plant fed from the control panel shall be controlled via front panel mounted rotary switches giving auto/off/hand selection facilities as follows:
In the auto position the item of plant will run under the dictates of the controller or time clock. In the off position the item of plant will be switched off regardless of the status of the controller or time switch or BMS. In the hand position the item of plant will operate regardless of the status of the controller or time switch or BMS, but primary interlocks will still safeguard equipment.
Duty/Stand-by Arrangement for pumps and fans etc..
Twin headed or duplicate single headed pump sets arranged to operate in duty and standby mode as follows: a) From the start signal, the duty circulation pump shall be called to run. If after a time delay of 30 seconds flow is not established by means of a differential pressure switch (DPS) between the common suction and delivery pipework connections, the pump shall be taken out of circuit and pump failed alarm raised. b) The standby pump shall automatically be called to run. If after a time delay of 30 seconds flow is not established across the DPS the pump shall be taken out of circuit and pump failed alarm raised.
Where multiple plant installations are to be sequenced or switched on/off to match the system demand a Lead Unit switch to control the lead unit i.e. 1-2-3/2-3-1/3-1-2 shall be fitted. Each item of equipment shall have indicating lamps mounted on the face of the panel to indicate Run or Normal and Trip or Fault conditions.
Arrange for all selector switches serving plant subject to AUTO control to have auxiliary contacts to signal to the Building Management System (when specified) when the drives are not in auto control.

2.28.20 Electro-Magnetic Interference

Install measures to prevent electro-magnetic interference with control panel operation and to prevent electromagnetic interference from control panels affecting other electrical equipment.
Measures likely to be required include:- Supply motor control panels direct from the main LV switchboard. Wire control systems

in twisted pair cable. Run control cables away from mains cables. Use armoured cables for power circuits and full size neutral conductors. Fit voltage surge suppression devices to mineral insulated cables, relay and contactor operating coils and vulnerable electronic equipment.
Fit input and output harmonic filters to electronic inverters and motor soft starters.

2.28.21 Controls & Control Devices

The selection of the correct control equipment and sizing of control valves and control dampers shall be the responsibility of the Contractor. All valve and damper actuators and loose equipment shall be compatible with the associated controller.
Detailed proposals shall be submitted for each element of the complete control system(s) for the CA's comment prior to equipment being ordered.
Work included under this section shall include for the supply and delivery of all control equipment to operate the respective systems, i.e.; thermostats, motorised valves, pressure switches, level switches, detectors etc.
On completion of the installation, the Contractor shall calibrate and set the systems to correct operation prior to demonstration to the CA.
Where ancillary relays, controllers, contacts, etc., are required to fulfil the control function these shall be provided. NOTE - For packaged items of equipment such as booster pumps, pressurisation units, etc., the Contractor shall ensure that all additional relays, controllers and contacts, etc., are included by their respective manufacturers to enable them to be interconnected to the main controls in the manner described in this Section.
Electrical/electronic power equipment shall be suitable for single phase electric supply up to 230 volts, 50 Hz. Environmental control equipment shall be for a 24 volt electrical supply and provided with suitable transformers. Interlocking between MCC's, Packages, Fire Alarm Panels, Fireman's Switches, etc., shall be at 24V. When 230V interlocking cannot be avoided, sufficient isolating contacts and safety warning labels shall be supplied wherever a live circuit enters separately isolated apparatus.
All electrical equipment installed shall, where appropriate, comply with BS 7671 and shall be provided with a means of isolation of the electrical supply to each component. Where equipment requires other than a 230V 50Hz supply, all necessary voltage transformers, rectifiers etc., shall be provided separately, integrated with the various packaged equipment, or incorporated within the MCC. The supplies shall be suited to the connected loads.
Unless stated otherwise elsewhere, all electrical/electronic controls shall be located within the MCC's. Loose items of control equipment which require independent mounting shall be fixed by the Contractor.
All BMS type controllers will be mounted in a separate section. The installation diagrams/drawings shall indicate all components including interlocks, relays, alarms and alarm indication.

2.28.22 Electronic Unit Controllers

Controllers shall be of the modular type suitable for controlling motorised valves, dampers, electric re-heaters, etc., to achieve a temperature in the space within + or – 0.5°C of the set point. The controllers shall operate on a 24 volt electrical supply and be suitable for operating in ambient temperatures of 0°C to 40°C.

2.28.23 Motorised Control Valves

All automatic control valves shall be compatible with the associated controller.
All motorised control valves shall provide 100% tight shut-off facilities to flow and/or bypass, whichever is suitable to it's control application, unless indicated otherwise elsewhere.
Two port control valves shall be used in preference to 3 port diverting to control heater and cooler batteries when the respective pumped system is fitted with a variable speed pump or automatic system pressure stabilizing control. Two port control valves shall be fitted in the flow or return depending upon the particular requirements.
Three-port automatic control valves shall be installed in the return connections of water heater and cooler batteries in order to either restrict or vary the flow temperature through each battery in accordance with the fluctuations in load when the installed pumps are constant flow..
Each valve intended to restrict flow through a battery shall be suitable for installation in the return connection to provide a diverting effect with a mixing valve application.
On plant shutdown, motorised valves shall motor to the following conditions: a) First in line heater/cooler battery for an AHU - valve full open to coil. b) Any battery forming a part of an external mounted AHU - valve full open to coil. c) Any battery not in i) or ii) - valve fully closed to coil. d) Hot water calorifiers - valve closes fully to calorifier.

2.28.24 Dampers on Equipment

All dampers on equipment to be operated by the central control system, shall be compatible with the associated controller.
Dampers provided on items of equipment, i.e.; air handling plant, shall be complete with actuating arms, connecting rods and gearing. The installation by the of suitable actuators, brackets, linkages and fixings, etc., shall be included for the operation of these dampers in accordance with the particular requirements.

2.28.25 Fire Dampers

Fire dampers to be monitored or operated by smoke alarms shall be fitted with an end stop micro- switch. The closed damper status, during the plant run periods, shall be relayed to a monitoring panel.
Where fire dampers are specified to close by the detection of smoke they shall be operated by an electric solenoid valve actuator. The damper open/close status shall be relayed to the fire alarm detection panel. When a damper closes due to a fault, the fault shall be relayed to the panel but will not energise the fire alarms. The fire alarms shall only energise upon the detection of smoke. The solenoid operating range shall be compatible with that of the smoke detection system. Powered fire dampers shall automatically close upon power failure and automatically reset to open position when power is restored.

2.28.26 Louvre Control Dampers

All louvre damper actuators shall be compatible with the associated controller.
Louvre control dampers, except those forming an integral component of equipment, shall be of the multi-leaf parallel blade type with galvanised frames and blades. Blades and frames shall be made of galvanised sheet steel suitably fastened and braced for maximum strength. Bearings shall be of oil impregnated sintered bronze and shall provide constant lubrication. Ductwork, transition pieces and blanking plates to suit these dampers shall be manufactured and installed by the ductwork installation Contractor.

2.28.27 Control Dampers

All control damper actuators shall be compatible with the associated controller.
Control dampers, except those forming an integral component of equipment, shall be of the low leakage; multi-leaf opposed blade type with galvanised frames and blades. All control dampers shall be characterised and have a leakage factor of less than 0.5% when closed. Frames shall be made of galvanised sheet steel formed into channels suitably fastened and braced for maximum strength. Blades shall be no larger than 150mm in size and consist of two formed sheets, spot- welded together for extra strength to withstand high velocities and static pressure. Bearings shall be oil impregnated sintered bronze and provide constant lubrication. Synthetic elastometer seals on the blade edges and frame shall provide a complete seal when the damper is closed.
Dampers shall be sized by the control supplier to provide adequate resistance for effective control. Ductwork, transition pieces and blanking plates to suit these dampers shall be manufactured and installed by the ductwork installation Contractor.
2.28.28 Power & Control Cabling Installation
The incoming power supply cable(s) to the control panel and/or motor control centres shall be supplied and installed by the Electrical Services installation contractor.
Power & control cabling and containment from the control panel(s) and the mechanical plant and control devices shall form part of the scope of works for the mechanical services. The Contractor shall be responsible designing the control circuits in accordance with the performance requirements.
The cabling systems shall comprise all cables, cable rack or tray, fixings, terminations and cable identification. The system shall be installed and fully tested in accordance with the Electrical Services Standard Specification and the minimum requirements herein.
The Contractor shall obtain from the equipment suppliers, a full schedule of motor starting and running currents plus other equipment ratings and set these against the tender drawing power distribution diagram and submit to the CA for his/her comment. The installation shall be carried out in accordance with the installation field wiring diagrams, cable routing drawings and cable schedules produced by the Contractor.

2.28.29 Power Cabling

The installation of cables shall be inclusive of the termination and testing at either end. All cable routes shall be site measured after installation of cable support systems to verify ordered lengths. The final location of terminations shall also be site verified in conjunction with the final cable routes adopted.

2.28.30 Cable Support Systems

Cables shall be fixed to cable rack, cable tray, uni-channel or mono-point fixed as appropriate. Cable support systems shall generally be utilised to provide the most economic system of cable support in terms of strength, durability and practicality of installation. Multi-run cables from each Motor Control Centre shall be supported by medium to heavy duty cable racks according to the number and size of cables carried thereon.
Subsidiary minor cable routes shall be supported by heavy duty cable tray or uni-channel as appropriate.
Mid point deflection of cable racks and trays shall not exceed the manufacturer's recommendations. The spacing of support hangers and brackets shall be such as to ensure compliance with this requirement.
Cables shall be fixed to racks or trays using cable cleats for sizes of cables exceeding 30mm in overall diameter. Cable diameters below this size may be fixed using releasable ratchet cable ties. Cable support systems shall be suspended from soffits and structural steelwork when run in the horizontal plane. Rod suspension sets shall be utilised, spaced to suit the maximum deflection requirements. Structural steelwork shall not be drilled. Occasional side restraints shall be installed to prevent lateral

deflection. Details of proposals shall be subject to acceptance prior to installation. Cable support systems shall be supported from the structural frame when run in vertical plane. Suitable brackets shall be included to achieve the satisfactory support of vertical systems. Details of proposals shall be subject to comment prior to installation. Cable support drawings for the purpose of indicating routes, sizes, elevations and supporting methods for the proposed cable system installation shall be submitted to the CA for comment prior to installation.
The installation shall be fully coordinated with all other services, Architectural room layouts and the building structure.

2.28.31 Identification of Cables

Fit coded markers at each end of all conductors and record the conductor references on the 'As Fitted' drawings. Use distinct and different colours for ELV and LV cable systems.
Loosely loom and identify all cables prior to termination. Identify both ends of each control cable by means of slip on cable markers suitable for the overall diameter of the cable concerned. The markers shall indicate the alphanumeric references shown on the wiring connection diagrams. A maximum of five character markers shall be allowed for each reference.
Provide a cable schedule to the equipment suppliers responsible for the supply of each motor indicating cable size, number of cables and cable entry size required to ensure correct fitment of terminal boxes.

2.28.32 Cable Containment

Cables passing through structural or high fire integrity elements of the building shall exit via multi- cable transits of an acceptable design. The containment frames shall be appropriately sized to be built-in under the building contract. Appropriately sized cable blocks and blind blocks shall also be sufficient to completely seal the containment after the installation of cable is complete.
The location and sizes of all proposed containments shall be verified prior to their installation. Schedules and drawings shall be provided by the Contractor for this purpose.

2.28.33 Final Connections to Motors and Equipment

Where plant or control equipment is supplied with flying leads, which if power leads are not long enough to be wired directly to the local isolators, install suitably IP rated and glanded, terminal boxes complete with fixed base and insulated connector block adjacent to the equipment item. Wire both flying lead and mechanical systems field wiring to the terminals in the boxes.
Unless specified otherwise elsewhere, make fused connections via PVC sheathed flexible conduits with captive gland terminations. Maximum lengths of flexible conduit to be 450mm.
Allow tails at each of the connection points as follows: a) 3.0m within the controls section of the mechanical control panels. b) 300mm beyond the flexible conduit allowed for sensors and other monitoring points. c) 300mm beyond the fixed adaptable box into which pre-wired tails for sensors are to be connected.
The lengths indicated above are for tendering purposes only. Confirm actual lengths in individual cases during installation.
Terminate each armoured multicore cable serving a motor directly into its local isolator or into an adaptable box after the isolator, containing a fixed base connector suitably insulated from the box sides. Use 85°C butyl rubber insulated copper cables for the tails between the isolator/adaptable box and motor terminals. Install these tails within flexible conduit as defined earlier.
Ensure that all cable cores are robust enough to make satisfactorily strong terminations, without the danger of stress fracture when the terminations are disturbed by installation of adjacent cores, or when terminations are made/unmade.
Terminate armoured power cables at the control panels on the appropriate gland plate at the top of the panel as applicable and earth each gland accordingly. Pass the unarmoured cable tail complete with bedding through the segregated power wiring section of the cable chamber beneath the gland plate, via a bushed entry into the wardrobe type panel/ respective compartment. Remove the cable bedding to allow the individual cores to be connected into the respective terminals. Loosely loom all tails in the cable chambers.
Motors shall be provided with terminal boxes for cable entry at 0°,90°,180° and 270°. The Contractor shall position the cable box to suit the disposition of cable or cables for entry to the motor. In general XPLE/SWA/LSF cables shall be used throughout and shall terminate directly at the motor terminal box. The Contractor shall leave sufficient spare cable to enable full and adjustment of the motor within its limits. Pumps shall be fitted with a plug and socket for easy removal of the pump after installation.

2.28.34 Control Cabling Installation

The control cabling system shall utilise all cable rack, tray or other subsidiary cable support systems, etc. previously described in and in all respects shall be compliant with the requirements of these clauses.
The installation shall be carried out in accordance with the installation field wiring diagrams, cable routing drawings and cable schedules.
Termination of the control cables shall be carried out in accordance with the manufacturer's wiring and schematic diagrams.

2.28.35 Field Control Devices

As a minimum, install large mushroom headed push to lock, twist to release type emergency stop buttons in double insulated

standard IP rating, polycarbonate enclosures. These shall be installed at each exit door from plant rooms, kitchens, laundries and other workshop/teaching facilities where gas is installed.
Ensure that emergency stop buttons are coloured red and labelled in accordance with the retirements of BS 7671.
Workshop and teaching facilities where the gas appliances do not have flame: Utilise PVC insulated single core cables run in fixed conduit terminated directly into the stop button enclosure for wiring to the emergency stop button circuits.
Arrange the emergency stop circuit such that operation of the emergency stop button deenergises the circuit contactor in such a way that the circuit contactor cannot re-energise and automatically restart the plant, when the button is released. Design this circuit so that the control circuit must be reset at the origin of the supply before the contactors can be reenergised. 2.28.36 Warning notices Labels shall be in accordance with Section Labels & Identification and in particular as given below:- . Labels shall be affixed on or adjacent to each motor controlled by a lock off stop pushbutton to state: "Isolate elsewhere before working on this equipment" plus a supplementary label to state: "Danger - this equipment is automatically controlled and is liable to start without warning"

2.29 Building management systems

A Building Management System shall comply with the following minimum requirements:-

2.29.1 Stand Alone

Control panels and field controls shall be hard wired and be operational stand-alone and not reliant upon the BMS for safe operation.

2.29.2 Building Protection

Fire alarms and sprinklers and automatic plant shut down, shall be hard wired to the respective control panels to enable the defined plant and accessories to respond according to the projects' agreed cause and effect schedule of performance and not reliant upon the BMS.

2.29.3 Interfaces

Where the BMS includes interfaces with remote sensors, the BMS network shall link all control panels and out stations to enable common sensors to be used for multiple functions. Hantsnet network systems shall not be used for linking control panels and BMS PCs.

Controllers in each panel shall have a touch screen interface to enable local interrogation without the need for a PC/laptop. Alternatively a switch labelled "standalone laptop/network" with connection port shall be provided on the front of the panel to enable interrogation of the controller by connection to a standalone laptop rather than from via the network.

2.29.4 Off Line

When the BMS is "out-of-action" or off line, the last recorded sensor inputs/outputs shall be maintained until the BMS is back on line.

2.29.5 Front End and Remote Access

BMS systems shall be either supervisor software or web browser based and permission for access through the software fire wall will be required and the contractor shall be responsible for making these arrangements by agreement and in liaison with the CA prior to practical completion:

2.29.6 Supervisor Software

BMS systems shall include a new dedicated PC located in the building manager's office with means of accessing outstations/controllers via a graphics based supervisor software package.

Alternatively the supervisor software shall be installed onto a dedicated supervisor server located at a defined office as confirmed elsewhere. The PC shall be linked to the building's ethernet to enable access to the BMS by any PC in the building network and to enable remote access.

All graphics generated information shall be submitted to the CA for comment prior to implementation.

2.29.7 Web Browser Based

Controllers may also be web server based which shall enable interrogation from any PC on the building's ethernet via a web browser (e.g. Internet Explorer). For a number of controller web servers on one site, log in shall be to one master controller, as opposed to logging into to each individual controller/outstation.

The master controller shall be linked to the building's ethernet via a local data point back to the main data hub. An IP address shall be provided by the users IT dept. The controller shall enable access to the BMS by any PC on the users network.

2.29.8 Information Relay

The web server or supervisor shall be capable of reporting system alarms via email

2.29.9 Access Requirements

The supervisor software or web server shall be suitable for providing the user with dedicated levels of access depending upon the user's requirements. Where no further instruction is given, access for the building user shall be limited to access to time and temperature set points adjustments, plant performance, system monitoring and energy consumption.

Temperature set points for the building user shall adjustable only within high and low level values and confirmed elsewhere. Only authorised staff shall be provided with access to all system parameters.

2.29.10 Database

The BMS shall be suitable for storing system performances to include internal and external temperatures, plant running times and failures. When specified, monitoring energy usage via dedicated meters shall be included. Unless directed otherwise, the database shall be of suitable memory capacity for storing not less than 12 months of performance information. The BMS database shall automatically notify the user at the end of each 12 month period, to allow the information to be transferred to an alternative software library to free up the BMS database.

2.29.11 Automatic Controls & BMS Training & Instruction

The Contractor shall set up the system and give detailed instruction to the building user and CA during the commissioning stage. This training shall be repeated within the first month after handover, 6 months into the defects period and also at the end of the defects period.

2.29.12 Inspection, Testing & Commissioning

2.29.13 Pre-delivery Inspections

Before dispatch subject the panels to physical inspection, routine dialetric tests to BS EN 60439-1 pages 74-75 and full operation testing. The manufacturer shall provide certificates recording the works inspections and tests.
Allow time in the programme and attendance for the CA to inspect the control panels at the maker's works on completion of manufacture and test and before delivery. Ten working days notice of readiness for inspection shall be given.

2.29.14 On-Site Testing & Commissioning

Following installation on site, the installation contractor shall: a) provide evidence that all wiring connections are correct b) check that the panels are clean of debris and that all holes are properly sealed c) check also that the functioning of all components and controls is correct, including the correct functioning of all interfaces with associated equipment d) measure power wiring insulation and earth loop impedance and record the results.
Special units such as variable frequency inverters shall be checked and commissioned by the makers, or according to the makers' specific instructions for the units fitted.
Measure and record all motor currents. Set motor overloads to motor nameplate full load currents. Note that Star/Delta starters normally have overloads installed in the Delta Loop and set to full load current x 0.58.
Ensure that during commissioning and test no motor which has reached normal operating temperature is started more frequently than twice in one hour, or according to the motor maker's instructions if different.

2.29.15 Witnessing & Training
Following installation on site and completion of all site tests, the Contractor shall allow ten working days within the programme time for the CA to witness all testing and commissioning that has been undertaken by the Contractor as described above.
The test results and control functions shall be demonstrated to the CA to prove that the controls fully meet the specified mode of operation as detailed elsewhere. The Contractor shall give detailed instruction to the building user and CA during the commissioning stage. This training shall be repeated within the first month after handover, 6 months into the defects period and also at the end of the defects period.

2.29.16 O&M Manuals & Record Drawings

Provide record documentation and drawings in accordance with Section Operating & Maintenance Instruction Manuals and Record Drawings.
The following is the minimum to be included for the Automatic Controls: .1 Description of equipment operation. .2 Schematic and wiring diagrams and panel general arrangement drawings. .3 Inspection and Test Certificates. .4 Data sheets and manufacturers' addresses for all panel components. .5 Recommended spares list. .6 Schedule of recommended periodic inspection and maintenance, including safety precautions.

2.29.17 Schedule of Contractors Submittals

Unless stated otherwise elsewhere the Contractor shall submit the following drawings and other documentation for the full scope of the Automatic Controls installation: i) Schedule of all drives and power supplies giving details of connected load, phase, proposed cable size and rating, fuse rating etc. ii) Manufacturers/installation/design drawings to include control panel schematic wiring and general arrangement drawings showing the mechanical systems wiring installation appropriately sized and duly co-ordinated with other equipment and installations. iii) Description of the controls strategy and mode of operation written in laymen's terms detailing automatic functions including all interlocks and operator facilities. iv) Where inverters are to be used - submit confirmation from both inverter and motor manufacturer that they are in agreement with the selection of the other's equipment. v) Equipment selections and calculations for all mechanical systems wiring together with any relevant design data used in the calculations. vi) Details of control panel labels and key diagrams and provide samples of the following: a) Emergency stop button. b) Local isolators. c) BMS/communications cables. vii) Areas of non-compliance with respect of segregation and separation. viii) Control panel works and assemblies type test certificates and details of the control panel construction and finish ix) Site control panel test and commissioning results x) Control panel as-fitted drawings and Operation & Maintenance Manuals xi) All submittals shall be issued to the CA for his comment not less than 14 days prior to manufacture and/or installation.

2.30 Metering Requirements

2.30.1 Heat Meters

The installation shall be as follows: Return: Immersed flow sensor Flow: 3⁄4" Ball valve with pocket sleeve The sensors shall come complete with 1.5m leads and be suitable for the orientation of the installation.
The heat meter unit shall operate within the following parameters: Temperature Range 1-120°C Flow 1.5 m3/h Temperature Differential Range (ΔT) 5 – 100 k Sensitivity + 0.01°C
The calculator shall be IP 65 and suitable for installation in ambient temperatures between 5- 55°C. It shall be battery powered with a minimum 5 year battery life. The multifunctional LCD display shall have 7 digits. It shall meet the requirements of EN 1434 The calculator shall be suitable for read outs via M-Bus interfaces and pulse output. It shall automatically save the meter readings daily.

2.30.2 Water Meter

The WRAS approved water meter shall be suitable for use in drinking water. It shall be installed with a minimum of 5x pipe diameter both up and downstream. The meter shall be orientated in accordance with the manufacturers instructions with the dial correctly orientated.
The water meter shall operate within the the following parameters:
Temperature Range 0- 30°C
The potential-free reed switch shall produce a pulsed output.
This can be to a compatible calculator which allows conversion to M-Bus should it be required.

2.30.3 Gas Meter

The WRAS approved water meter shall be suitable for use in drinking water. It shall be installed with a minimum of 5x pipe diameter both up and downstream. The meter shall be orientated in accordance with the manufacturers instructions with the dial correctly orientated.
The water meter shall operate within the the following parameters:
Temperature Range 0- 30°C
The potential-free reed switch shall produce a pulsed output.
This can be to a compatible calculator which allows conversion to M-Bus should it be required.

2.30.4 M Bus System

The master M Bus module enables remote data acquisition from a range of compatible heat and water meters. The master M-Bus module shall be suitable for direct connection to PC/laptop and have a digital display. There shall be an optional cascade module which can be used to collect data from additional meters over and above the master units standard number of M Bus slave meters The module shall be complete with the appropriate software to allow can be used to read and record information from the energy meters via Windows package to the Client's specification.

2.31 Thermal insulation

The thermal insulation shall be in accordance with the construction and manufacturers drawings, Specification, and Appendices and tender drawings.
Completed installations being defect-free, together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.

2.31.1 Outline scope of work Insulation as specified shall be applied to the following services:-

- Refrigeration pipework and equipment which is not factory insulated.
- Chilled water pipework.
- Mains cold water, cold water supply and hose reel systems.
- Domestic hot water services.
- Heating pipework not used as an effective heating surface.
- Heating & chilled water dearators and separators.
- Primary and secondary condenser pipework, including condenser plates.
- Cold water storage tanks except those supplied pre-insulated.
- Calorifiers and heat exchangers.
- Air conditioning and ventilation supply and extract/return air ducting, including fresh air intakes, flexible ducting and plenum boxes.
- Boilers, flues and generator flues, when not factory pre-insulated.
- Boilers, when not factory pre-insulated.
- Copper condensate waste pipework (from indoor air conditioner, fan coil units etc)

2.31.2 Insulation Materials

2.31.3 Global Warming Potential (GWP)

All thermal insulation to be used for pipework and ductwork shall satisfy the GWP requirements having a rating of less than 5. The contractor shall provide written confirmation that the insulation proposed meets this requirement prior to orders being placed.

2.31.4 General Requirements

The following insulation materials are generally acceptable for use within buildings, except where their use is restricted in specific areas:

(a) Rigid phenolic foam pipe insulation, nominal density 35 kg/m3 and with an aged thermal conductivity value not exceeding 0.018 W/me at mean temperature 10°C. Core face of sections coated with a non-odorous passive solution. All sections with factory applied reinforced aluminium foil facing.
(b) Rigid phenolic foam laminate, nominal density 40 kg/m3 and with an aged thermal conductivity value not exceeding 0.018 W/mK at mean temperature 10°C. Laminate to have reinforced aluminium foil facing auto-adhesively bonded to one face during manufacture.
(c) Resin bonded mineral wool pipe insulation with factory applied reinforced aluminium foil facing, nominal density 130 kg/m3 and with a thermal conductivity value not exceeding 0.043 W/mK at mean temperature 100°C.
Resin bonded, foil faced, mineral wool duct insulation in a range of densities 36 kg/m3 dependent on location. Thermal conductivity value not exceeding 0.043 W/mK at mean temperature 100°C. Nitrile rubber, flexible, closed cell, CFC-free (ozone depletion potential of zero) elastomeric material and with a thermal conductivity value not exceeding 0.043 W/mK at mean temperature 100°C.
Tube form closed cell insulation* having a highly flexible elastomeric structure complete with a built in vapour barrier and a high resistance to water vapour transmission, as Armaflex Class 'O' or equivalent, may be used on refrigerant, domestic water services, heating and chilled water pipework.

*The extent of this type of insulation shall be restricted to coiled copper and stainless steel pipework systems and other piped services where it not practical to apply other types of pipework insulation and only where it's use is approved by the CA. It shall not be used in situations where it cannot be inspected and replaced without dismantling the building structure and/or service ducts in which it is contained. Sheet form may be used on ductwork within plant rooms where it is required to include an additional protective finish. It shall be applied and supported as necessary to prevent sagging. The sheet insulation shall not be reliant on any aluminium cladding finishes to support it and prevent sagging.
The application of the closed cell insulation shall be applied by trained personnel and strictly in accordance with the manufacturer's instructions. Any insulation which has been applied deviating from this approved method of application shall be rejected and replaced by the Contractor at his own expense.

2.31.5 Material Restrictions

All insulation materials shall be free from the use of CFCs in their manufacture and as a finished product. Phenolic foam insulation shall not be used on services operating above 120°C. Insulation materials containing man-made mineral fibre are not to be installed in kitchens, food preparation areas, food storage areas or other aseptic areas (including ceiling voids and ducts and access from these areas).

2.31.6 Fitting of Insulation

Any insulation work which is inferior in quality to the approved installed samples of the shall be removed and replaced by the Contractor at his own expense. Insulation shall be fitted fully in accordance with the manufacturers recommendations. The Contractor shall protect all adjacent surfaces of plant and equipment during the insulation programme.
Insulation shall be of uniform thickness and shall not vary from the thickness specified by more than 10%. To ensure that the correct thickness of insulation has been applied, the Contractor shall if required, cut out one section for examination of each type of insulation specified. The Contractor shall allow for the cost of cutting out and making good in his tender. Unless otherwise agreed with the CA, pipes shall be insulated individually. A minimum of 25mm clearance shall be maintained between final insulated surfaces of adjacent pipes. Insulation on all access doors, manhole covers etc shall be left clear of the permanent insulation to permit removal and replacement without damage and all exposed edges shall be sealed.
The Contractor shall provide the CA with a manufacturer's certificate of declared thermal conductivity value appropriate to the temperature of use. The certificate shall be included in the Operation and Maintenance Manual.
Particular attention shall be given to the final appearance and finish of all insulation which shall, on completion, present a neat and symmetrical appearance running true in line with pipe layouts.

2.31.7 Pipework Insulation

Pipework shall be insulated with pre-formed, foil faced sections one metre in length. Insulation shall be a close fit to the pipe with tight butt joints. After installation all joints in the facing are to be sealed with 50 mm wide self adhesive aluminium foil tape. All insulation regardless of outside finish shall be supported with non-ferrous metal bands applied firmly and squarely at not greater than 300 mm centres with not less than two bands on any shorter length.
The term 'pipework' in this Clause is deemed to include all pipe fittings.
Insulation thickness shall be as indicated in the tables later in this section.

2.31.8 Cladding

Pipework shall be insulated and then finished as defined in the selection table and <u>(where specifically identified in the particular specification)</u> in accordance with one of the following;
a) Stucco embossed aluminium sheeting to the following thickness:

- Vessels and flue piping 1.25 mm
- Pipework 100 mm diameter and above 0.91 mm
- Pipework up to 100 mm diameter 0.70 mm

Cladding shall include manufactured bends, tee sections and end caps at termination points. Securing of cladding on hot services shall be pop rivets or self tapping screws at maximum 100mm centres.
Securing of cladding on services operating below ambient shall be 12 mm wide aluminium or stainless steel strapping with matching seals at maximum 300 mm centres.

b) Grey coloured plastic sheet with taped circumferential and plastic riveted longitudinal joints. Valves in services risers/ducts, boiler and plant rooms Insulation shall comprise of one of the following:

(i) All valves, flanges, unions, expansion joints, dirt and air separators on hot services shall be enclosed in purpose made covers comprising mineral wool blanket sandwiched within silicone rubber coated glass fibre fabric. The covers are to be demountable and secured with Velcro pads or nylon pull cords.

(ii) Valves, flanges, unions and expansion joints on cold services shall be insulated with foil faced oversize sections or purpose made moulded foam boxes. The insulation and foil facing on adjacent pipework is to be taken into the box and sealed down to the pipe surface. Joints in the box are to be sealed with 50 mm wide self-adhesive aluminium foil tape.

2.31.9 Concealed Installation

Concealed insulation is defined by pipework which is accessible and located above suspended ceilings and floor voids, services ducts (internal and external), cupboards and other or enclosed insulation.
Pipework shall be insulated as defined in the selection table for concealed within accessible ceiling and floor voids, builders ducts (internal and external), cupboards and other hidden or enclosed non- habitable spaces.

2.31.10 Pipework External to Buildings

Pipework shall be insulated and weather protected as defined in the selection table and <u>(where specifically identified in the particular specification clauses)</u> in accordance with one of the following:

a) Two full applications of a polymeric emulsion mastic such as Childers CP55 or similar (two colour system), reinforced with open weave glass cloth No 10 between coats. (Childers Encacel T to replace CP55 under low temperature or damp conditions).
b) Insulation to be wrapped in 0.8 mm thick PIB sheeting with 30mm wide longitudinal laps and 50 mm wide circumferential laps all solvent welded to be weather tight.
c) Aluminium cladding 1.0 mm thick with overlapping joints to form a watershed and be sealed with mastic.

2.31.11 Valves & Other Line-Mounted Equipment

External to the Building &
Internal to the Building, Within Unheated Plantrooms & Service Risers, Ducts & Undercrofts, Basements, etc

All valves, flanges, unions, control valves, accessories, and expansion joints located externally on hot services shall be contained in insulated coverings, with tailor-made "soft" jackets with Velcro fastenings to TBA textile EKS409S or equivalent. All jackets shall be non combustible as to BS 476 Part 4, 6 &7 and it shall conform to BS5422.
Insulation jackets shall be suitable for surfaces with operating temperature up to 250°C. The jacket insulating material shall have a thermal conductivity not greater than 0.049 W/mK.
Jacket shall be constructed as follows:

Inner & Outer face: 440 g/m2 glass cloth coated both sides with silver silicone elastomer
Fabric thickness 0.4 mm
Tested to BS 476 part 6 & 7
Insulation: 50mm x 45 kg/m3 mineral fibre
Fasteners: Flame retardant Velcro straps and drawcords to edges
Draw cord: 4mm spun fibreglass cord
Thread: Flame retardant thread
ID label : Laminated

All jackets shall be design to enclose the entire valve body including bonnet flange, mating flanges and overlap adjacent line insulation by a minimum of 50mm. Jackets wherever practical shall be constructed in one piece. All jackets above 500mm x 500mm shall be spiked at 75cm centres with stainless steel pins to prevent the insulation insert from shifting or pulling away from the outer jacket. All jackets shall be of sewn construction. All flaps shall be installed in a manner which provides suitable water shedding.

On Hot Water/Heating Pipework Mounted Externally, and all Chilled Water Pipework:
The insulation and any over-covering, vapour-sealing of the adjacent joining pipework shall be carried through over the line-equipment body, which shall be sealed with clear mastic at any joints to equipment bod – finally having wrap-around jacket fitted over.

2.31.12 Pipe Supports

On services up to 100°C pipework is to be separated from the clip or strut by fitting high density phenolic foam 'K' blocks. The K blocks will have a bonded spreader plate and full wrap around foil facing. When wood blocks are fitted they are also to be supplied with a fully bonded foil facing. Thickness of blocks will match adjacent insulation and they are to overhang the clip by 25 mm on either side. Joints between blocks and adjacent insulation are to be sealed with tape on services below 20°C.

2.31.13 Vapour Barriers

Vapour barriers shall be applied to the outside of all insulation applied to all plant, equipment, operating at temperatures below that of the surrounding ambient air. The barrier shall comprise of a sealed coating or sheet material that is resistant to the passage of water vapour.
The vapour barrier shall comply with the requirements of BS 5422 (Table 1) and BS5970 (Table 7) and Building Regulations Class 0 definitions. The fire performance of the complete assembly of insulating and finishing materials should not be reduced from the limits specified.
Particular care and attention shall be paid to ensure the integrity and continuity of the vapour barrier particularly at termination points which should be taped back to the equipment surface.

2.31.14 Ductwork Insulation

All ductwork shall be insulated with foil faced rigid insulation slab, slotted slab or flexible blanket dependent on the location.
Rigid slab insulation where fitted to rectangular ductwork is to be cut on site so that the top and bottom slabs overhang by the thickness of insulation, on all corners.
The insulation is to be bonded to all faces with a two way fire resistive contact adhesive. Insulation to inverted surfaces and sides of ducts where they exceed 0.5 metres in depth is to be additionally supported with pre-bonded nylon hangers and washers at 300 mm centres.
Insulation thickness shall be as indicated in the tables later in this section.

2.31.15 Plant Rooms and Other Viewable Insulation

Ductwork shall be insulated and then finished as defined in the selection table and (where specifically identified in the particular specification clauses) in accordance with one of the following:

a) 0.91mm Stucco embossed aluminium sheeting secured with 'pop' rivets or self tapping screws at maximum 100 mm centres

b) Grey coloured plastic sheet with taped circumferential joints and riveted longitudinal joints.

2.31.16 Concealed

Concealed insulation is defined by ductwork which is accessible and located above suspended ceilings and floor voids, services ducts (internal and external), cupboards and other or enclosed insulation.

Ductwork shall be insulated as defined in the selection table except that mineral wool insulation will be enclosed in 25 mm mesh galvanised wire netting.

2.31.17 External to Buildings

Ductwork shall be insulated and weather protected as defined in the selection table and in accordance with one of the criteria given for pipe insulation.

NB: Insulation to the top side of external ductwork is to be laid to falls to avoid ponding in way of the weather proofing membrane.

2.31.18 Ductwork Supports

Insulated ductwork shall be isolated from support bars by the inclusion of foil faced heavy density phenolic foam strip.

The spacer is to match the thickness of adjacent insulation and shall overhang the support bar by 25 mm width each side. Joints between the spacer and adjacent insulation are to be sealed with self adhesive aluminium foil tape.

2.31.19 Insulation of Tanks and Cisterns

All cold feed and storage tanks and cisterns located in plant areas shall be insulated with 30 mm thick foil faced phenolic foam laminate or 50 mm thick foil faced resin bonded mineral wool slab, secured to the surface with a combination of adhesive and insulation hangers/washers. All joints in the foil facing to be sealed with 75 mm wide self adhesive foil tape.

Tank lids and inspection openings to be similarly insulated with removable covers. In plant areas insulation to be finished with Stucco embossed aluminium sheeting or grey coloured plastic sheeting. In roof areas the foil facing to insulation constitutes the final finish.

2.31.20 Services Identification

All services shall be identified by the use of the identification bands located at four metre centres for voids, ducts and false ceilings and in plant rooms around the whole circumference of the service and at all points where the service cannot be readily identified. The identification bands shall comprise of non adhesive colour coding pipework banding and laminated self adhesive tape(s) to comply with BS1710 & BS4800 applied adjacent to each band. The tape(s) shall include the following:

- Service identification tape by means of words
- Flow indication tape by means of words
- Direction of flow indication tape by means of arrows Ductwork shall be identified by means of service arrows, indicating service and direction of flow in accordance with DW/144.

2.31.21 Insulation Material/Covering

Unless other material coverings are specified in the Particular Specification Section, the following schedule shall be used:-

Services	Location	Insulation Material	Covering
Steam, Cond., HTHW & MTHW	Plantrooms/ Occupied areas	Phenolic foam Laminate	Aluminium sheet (if specified), otherwise Aluminium foil.
LTHW, Domestic HWS	Plantrooms/ Occupied areas	Phenolic foam section	Aluminium sheet (if specified), otherwise Aluminium foil.
	Service Ducts/Voids	Phenolic foam section	Aluminium foil.
	External to Building	Phenolic foam Laminate	PIB Rubber
CHWS & Chilled Water	Plantrooms/ Occupied areas	Phenolic foam Laminate	Aluminium sheet (if specified), otherwise Aluminium foil.
	Service Ducts/Voids	Phenolic foam Laminate	Aluminium foil.
	External to Building	Phenolic foam section	PIB Rubber
Ventilation Ductwork	Plantrooms/ Occupied areas	Mineral wool Ductslab/ Lamella	Aluminium foil.
	Service Ducts/Voids	Mineral wool Ductslab/ Lamella	Aluminium foil.
	External to Building	Lamella	PIB Rubber

2.31.22 Pipework insulation: Chilled & Cold Water Services with ambient at +25°C.

Required thickness of Low K Phenolic Foam (PF) or Mineral Fibre (MW) faced with bright Class O aluminium foil with still air conditions of +25°C and 80% relative humidity.

Pipe Size	Pipe Size	Thickness of Insulation (mm)					
Inside Dia.	Outside Dia.	Fluid Temperature					
		10°C		5°C		0°C	
		PF	MF	PF	MF	PF	MF
15	21	15	40	15	50	20	75
20	27	15	40	15	50	20	65
25	34	15	40	20	50	25	65
32	42	15	40	20	50	25	65
40	48	15	40	20	50	25	65
50	60	15	40	20	50	25	65

2.31.23 Pipework insulation: Chilled & Cold Water Services with ambient at 25°C.

Required thickness of Low K Phenolic Foam (PF) or Mineral Fibre (MW) faced with bright Class O aluminium foil with still air conditions of +25°C and 80% relative humidity.

Pipe Size	**Pipe Size**	**Thickness of Insulation (mm)**					
Inside Dia.	**Outside Dia.**	**Fluid Temperature**					
		10°C		**5°C**		**0°C**	
		PF	MF	PF	MF	PF	MF
15	21	15	40	15	50	20	75
20	27	15	40	15	50	20	65
25	34	15	40	20	50	25	65
32	42	15	40	20	50	25	65
40	48	15	40	20	50	25	65
50	60	15	40	20	50	25	65
65	76	20	40	20	50	30	65
80	89	20	40	20	50	30	65
100	114	20	40	20	50	30	65
125	140	20	40	20	50	30	65

2.31.24 Pipework Insulation: Hot Water Services with ambient at 10°C.

Required thickness of Low K Phenolic Foam (PF) or Mineral Fibre (MW) faced with bright Class O aluminium foil for non-domestic hot water services operating at 60°C, with ambient at 10°C.

Pipe Size	**Pipe Size**	**Thickness of Insulation (mm)**	
Inside Dia.	**Outside Dia.**	**PF**	**MF**
15	21	15	40
20	27	15	40
25	34	20	50
32	42	20	50
40	48	20	50
50	60	20	50
65	76	20	50
80	89	20	50
100	114	25	50
125	140	25	50
150	168	25	50

2.31.25 Pipework Insulation: Heating Services with ambient at 10°C

Required thickness of Low K Phenolic Foam (PF) or Mineral Fibre (MW) faced with bright Class O aluminium foil for non-domestic hot water heating services operating at 80°C, with ambient at 10°C.

Pipe Size	Pipe Size	Thickness of Insulation (mm)	
Inside Dia.	**Outside Dia.**	**PF**	**MF**
15	21	15	50
20	27	20	50
25	34	20	40
32	42	20	40
40	48	20	40
50	60	25	50
65	76	25	50
80	89	25	50
100	114	25	50
125	140	25	50
150	168	25	50

2.31.26 Pipework Insulation: Heating, Domestic Hot Water Services with ambient at -1°C (Unheated Indoor Areas)

Required thickness of Low K Phenolic Foam (PF) or Mineral Fibre (MW) faced with bright Class O aluminium foil for domestic hot water, non-domestic hot water heating services operating at 60-80°C, with ambient at -1°C.

Pipe Size	Thickness of Insulation (mm)	
Outside Dia.	**PF**	**MF**
15	15	30
22	20	40
28	20	40
35	25	40
42	25	40
54	25	50

2.31.27 Pipework Insulation: Minimum insulation thickness required to give protection against freezing under commercial and institutional conditions.
Phenolic Foam (PF) or Mineral Fibre (MW)

Initial Water Temperature		**+2°C**		**+2°C**	
Minimum Ambient Temperature		**-6°C (Indoor Unheated)**		**-10°C (Outdoor)**	
Evaluation Period		**12 Hrs.**		**12 Hrs.**	
Permitted Ice Formation		**50%**		**50%**	
Pipe Size (mm)		**Thickness of Insulation (mm)**			
Outside Dia.	**Inside Dia.**	**PF**	**MF**	**PF**	**MF**
Copper Pipework					
15	13.6	25	80	70	420
22	20.2	15	25	25	60
28	26.2	15	20	15	30
35	32.6	15	20	15	20
42	39.6	15	20	15	20
54	51.6	15	20	15	20
76	73.1	15	20	15	20
108	105.0	15	20	15	20
Steel Pipework					
21.3	16.0	20	50	45	175
26.9	21.6	15	25	20	60
33.7	27.2	15	20	15	30
42.4	35.9	15	20	15	20
48.3	41.8	15	20	15	20
60.3	53.0	15	20	15	20
76.1	68.8	15	20	15	20
88.9	80.8	15	20	15	20

2.31.28 Ductwork insulation minimum thickness – Warm Air:

Phenolic foam laminate or foil faced mineral wool slab on warm air ductwork

Temperature difference between internal warm air and ambient air						
	Up to 10°C		**11 to 25°C**		**26 to 50°C**	
Thermal Conductivity	0.018	0.034	0.020	0.037	0.023	0.040
Wall of insulation	20	40	25	50	35	65

2.31.29 Ductwork insulation minimum thickness – Cooled Air:

Phenolic foam laminate or foil faced mineral wool slab on warm air ductwork

Temperature difference between internal warm air and ambient air						
	Up to 10°C		**11 to 25°C**		**26 to 50°C**	
Thermal Conductivity	0.018	0.034	0.020	0.037	0.023	0.040
Wall of insulation	20	40	25	50	35	65

Based on ambient + 25°C 80% rh

2.31.30 Insulation for Extract & Recirculation Ductwork

All air conditioning and ventilation extract and recirculation ductwork shall be insulated with rigid phenolic foam laminate (PF) or foil faced resin bonded mineral wool slab (MW)..

	PF	**MW**
In plantrooms and service shafts/risers	20mm	38mm
Externally exposed	30mm	65mm
In occupied spaces and local heated	None	None

2.32 Electric Trace Heating Protection

This section details the requirements for the supply and installation of the various systems of electric trace heating scheduled as follows:

- Freeze protection of exposed Mechanical Services and diesel fuel oil lines.
- Temperature maintenance of single pipe domestic hot water systems.
- Prevention of snow/ice damage to gutters, roofs, rainwater outlets and pipes.

All electric trace heating cables shall be of the energy efficient self-regulating polymeric type whose power output decreases with increasing temperature, manufactured, installed and tested in accordance with BS.6351 - Electric Surface Heating and suitable for a 230 volt, single phase 50 Hz electrically supply.

The self regulating trace heating cables shall be capable of maintaining the defined power output for a period in excess of 25 years.

Ensure that the electric trace heating cable manufacturer has available a trained and competent field engineer for providing technical support and installation training or provide a list of approved Specialist Sub-Contractors. All electric trace heating systems shall be installed, tested and terminated strictly in accordance with the manufacturer's instructions.

Thermal insulation shall be applied to the pipework, flanges, unions, valves etc. without delay to avoid unnecessary risk of damage to the trace heating cables.

All electric wiring between the trace heating circuit terminal units, control sensors/systems (where required) and local distribution boards or motor control centres/control panels shall be carried out by others in the Electrical Services Contract. Each trace heating circuit shall be protected electrically by use of a type 3 or 4 circuit breaker to BS 3871: Part 1 or equivalent in combination with residual current devices and sized in strict accordance with the heating cable manufacturers recommendations. These shall be incorporated in the local distribution board or motor control centre/control panel as specified elsewhere.

Each trace heating circuit shall have an automatic contactor with an SP&N isolator, HAND/OFF/AUTO selector switch and terminals for remote control, complete with a "MAINS ON" lamp and "HEATING CABLE OPERATING ON" lamp. These shall be incorporated in the local distribution board or motor control centre/control panel as specified elsewhere.

The electric trace heating system components for power connections, tee splices etc., shall except in special circumstances, take the form of insulation displacement type with all other ends being terminated with silicone gel end seals to a minimum of IP65 for outdoor application and IP54 for indoor application.

2.32.1 Freeze Protection to Exposed Mechanical Services

The freeze protection electric trace heating cables shall be provided and fixed on all insulated external pipework above ground and insulated pipework in unheated areas to protect the pipe contents from freezing.

The electric self regulating trace heating cables shall incorporate a modified polyolefin/fluoropolymer outer jacket, tinned copper braid and modified polyolefin over jacket.

Electric trace heating cables shall be fitted to the whole of the following exposed insulated pipework and fittings including control valves, isolating and balancing valves, non-return valves, strainers, orifice plates, flanges, unions, etc.

- LTHW heating flow and return mains - maximum pipe contents temperature 85°C (self regulating heater cables shall be capable of withstanding 85°C continuous).
- All cold water supply services - maximum pipe contents temperature 10°C
- Fire protection services - maximum pipe contents temperature 10°C
- Domestic hot water supply on a two pipe flow and return system - maximum pipe contents 60°C.

All electric trace heating cables shall be adequately sized to compensate for the heat losses from insulated pipes to ensure that the exposed pipelines do not freeze during extended cold periods when the ambient air temperature is minus 10°C.

Where traced heated pipework enters a building, housing, air handling unit, or other equipment, the heater shall extend a minimum of 500mm inside.

All electric trace heating cables, weatherproof junction boxes, power connection and end seal kits, adhesive glass tape for metal pipes, aluminium tape for plastic pipes, "electric traced" labels, insulation entry kit, ambient and pipe sensing thermostats etc., shall all be as manufactured by Raychem Ltd or other equal manufacturer approved by the Contractor.

2.32.2 System Components

All cold water, fire protection and two-pipe domestic hot water services shall be freeze protected with Raychem Ltd., or equivalent, WinterGard FS-A-2X trace heating cable, having a power output of 10.9 watts/metre at 5°C, and installed to a maximum circuit length of 150 metres.
All LTHW heating and diesel fuel oil services shall be freeze protected with Raychem Ltd., or equivalent, WinterGard FS-C-2X trace heating cable, having a power output of 30.3 watts/metre at 5°C, and installed to a maximum circuit length of 90 metres.
All MTHW heating services shall be freeze protected with Raychem Ltd, or equivalent, Chemlex Auto-Trace 4XTV trace heating cable, having a power output of 13.5 Watts/metre at 5°C, and installed to a maximum circuit length of 140 metres.
Trace heating cables shall be installed straight traced with minimum thermal insulation thickness and number of heater circuits as detailed in the following table:-

	Mineral Wool Thickness (mm)		
Pipe Size (mm)	**Cold Water, Chilled Water,**	**LTHW Heating and Diesel**	**MTHW Heating**
15	25	25	20
20	25	25	30
25	30	25	30
32	30	30	30
40	30	30	30
50	30	30	40
65	30	30	40
80	30	30	40
100	40	30	40
125	40	30	40

Note 1 a) Max. pipe contents not exceeding 65°C
b) Ambient temperature, minus 10°C
c) Straight traced with Raychem, Wintergard FS-A-2X heating cable.
Note 2 a) Max. pipe contents not exceeding 85°C
b) Ambient temperature, minus 10°C
c) Straight traced with Raychem, Wintergard FS-C-2X heating cable.
Note 3 a) Max. pipe contents not exceeding 120°C
b) Ambient temperature, minus 10°C
c) Straight traced with Raychem Chemelex auto-trace 4XTV heating cable

Particular attention shall be given to providing extra trace heating cable length to overcome heat sinks such as valves, water meters, un-insulated pipe sleeves etc. All trace heating cables shall be terminated with insulation displacement connection components and gel seals with no heat shrinkable components in use. The exceptions being diesel fuel, MTHW and LTHW heating services, where standard junction boxes and heat shrink components shall be used.
All pipework with electrical trace heating shall be provided with suitable warning signs applied to the insulation at a spacing of not more than 3.0 metres apart and on alternate sides of the pipe.

The electric trace heating is to be sectionalised according to the maximum circuit lengths, each section/system being complete with the following:-

- All necessary trace heating cables.
- A weatherproof air sensing thermostat, except those circuits requiring pipe surface sensing weatherproof thermostat eg. all cold water, chilled water and fire services.
- All necessary system components
- Insulation entry kits as appropriate
- Fixing tape
- Warning labels.

Ensure that all trace heating is completely installed back to the junction boxes and tested prior to the application of the thermal insulation.

2.32.3 Temperature Maintenance for Hot Water Dead Legs (Where Particularly Specified)

2.32.4 Limited Use

This method of temperature control shall not be used for new installations. It may be suitable for existing single pipe installations where there is a risk of Legionella and will be preferable to stripping out copper pipework and installing new.
Old hot water systems comprising galvanised steel pipework shall be renewed with copper pipework with a pumped hot water circulation.
For Design & Construct contracts where it is a Client Requirement or within contracts where trace heating is agreed to be used by the CA, the elements shall be installed for the purpose of preventing Legionella and the following minimum requirements shall be deemed included.
The electric trace heating system shall be provided and fixed to maintain the design water temperature of all insulated single pipe DHW systems or DHW deadlegs by compensating for the unavoidable heat losses during the no flow conditions. The electric self regulating heaters shall be of the type specifically designed for domestic hot water systems, complying with BS 6351, BS 6700.
The electric trace heating cables shall be fitted to the whole of the insulated domestic HWS flow pipework and fittings including isolating valves and stopcocks, strainers, flanges, unions etc.
All electric heating cables shall be adequately sized to compensate for the heat losses from the insulated pipework and to maintain the contents of the system at a minimum temperature of 55°C with ambient temperatures as stated.
All electric trace heating cables, junction boxes, power connection and end seal kits, adhesive glass tape for metal pipes, aluminium tape for plastic pipes, "electric traced" labels, insulation entry kit etc., shall all be as manufactured by Raychem Ltd or other equal manufacturer approved by the Contractor or his appointed representative.

2.32.5 System Components

All domestic hot water system flow pipework located in heated internal areas shall be trace heated to maintain the temperature of the contents with Raychem Ltd, or equivalent, HWAT-D cable having a power output of 8.5 watts/metre at 55°C and installed to a maximum circuit length of 130 metres.
All domestic hot water system flow pipework located in roof voids or other unheated areas shall be trace heated to maintain the temperature of the contents with Raychem Ltd, or equivalent, HWAT-E cable having a power output of 10 watts/metre at 55°C and installed to a maximum circuit length of 105 metres.
Trace heating cables shall be installed straight traced with thermal insulation thickness' as detailed in the following table:

Domestic hot water service - flow temperature maintenance (one pipe flow only system) at 65°C max. storage temperature with electric trace heating.

	Mineral Wool Thickness (mm)	
Pipe Size (mm)	**Pipework in Internal Heated Areas**	**Pipework in Unheated Areas**
15	20	25
22	25	30
28	30	40
35	40	50
42	40	20**
54	50	25**
67	25**	30**
76	30**	40**

** = double-traced

Note 1 a) Ambient temperature 18°C
b) Average minimum maintained flow pipe temperature 55°C
c) Straight traced with Raychem, HWAT-D heating cable.

Note 2 a) Ambient temperature, winter 0°C, summer 25°C
b) Average minimum flow pipework temperature for winter 53°C
c) Average maximum flow pipework temperature for summer 63°C.
d) Straight traced with Raychem, HWAT-E heating cable.

Particular attention shall be given to providing extra trace heating cable length to overcome heat sinks such as valves, water meters, un-insulated pipe sleeves etc. Trace heating cables shall terminate where insulation finishes in all service ducts, floor and ceiling voids consistent with the maximum permissible length of un-insulated hot water pipes (deadlegs) detailed in table 11 of BS 6700. In no case shall trace heating terminate closer than 1.0 metre to a draw-off point.

All trace heating cables shall be terminated with insulation displacement connection components and gel seals with no heat shrinkable components in use. All pipework with electrical trace heating shall be provided with suitable warning signs applied to the insulation at a spacing of not more than 3.0 metres apart and on alternate sides of the pipe.

The electric trace heating is to be sectionalised according to the maximum circuit lengths, each section/system being complete with the following:

- All necessary trace heating cables
- All necessary system components
- Insulation entry kits as appropriate
- Fixing tape
- Warning labels.

Ensure that all trace heating is completely installed back to the junction boxes and tested prior to the application of the thermal insulation.

2.32.6 Identification and Plant Labels

Refer to Section Labelling and Identification.

2.32.7 O&M Manuals & Record Drawings

Refer to Section Operating & Maintenance Instruction Manuals and Record Drawings.

2.33 Identification & Labelling

Identification and labelling shall be in accordance with the construction and manufacturers drawings, Specification and Appendices and tender drawings.
Completed installations being defect-free, together with the final Operating, Maintenance & Instruction Manuals and Record Drawings, shall be handed over to the Contract Administrator (CA) before the issue of the Practical Completion Certificate.Pipework and ductwork
All pipework services irrespective of whether insulated or not shall be provided with colour coded identification banding and labels to B.S. 1710 and include the name of service, size & direction of flow.
All ductwork services irrespective of whether insulated or not shall be provided with colour coded identification banding and labels to HVCA DW/144 indicating service, size & direction of flow.
The identification bands and labels, on suitable background colours, shall be applied either by painting or by PVC tapes. Where colour coding is painted on, it must be carried out using heatproof paint. If not self-adhesive fit the PVC tape using double-sided adhesive tape.
The identification bands and labels shall be fixed at all junctions, at both sides of service appliances, false ceilings & bulkheads, wall penetrations, service duct openings and at intervals not exceeding 10m plus any other places where identification is considered necessary by the CA. The identification of all exposed services external to buildings shall be painted. PVC tapes are not suitable in this application. Banding sizes shall be strictly in accordance with the B.S.
Pipework and ductwork services exposed to view but not finished in cladding, foil or other self-finish shall be painted to a suitable B.S./RAL colour as advised by the Contract Administrator.
The Contractor shall note: In addition to the approved colour coding, the name of the piped and ducted service shall be bonded to the finished insulation, pipe or duct whichever is applicable. the lettering shall be 10mm high and black on white a background. The wording shall be aligned with the pipe or duct and not wrapped around. The wording of the service shall be positioned to one side of the colour coding bands and at the same intervals as the banding. Within the main plant room, an explanatory wall chart in tabular form, setting out the colour codes of B.S. 1710 Appendix D Table 3 shall be provided. Within the main plant room, an explanatory wall chart in tabular form, setting out the identification of ductwork to HVCA DW/144. shall be provided. A copy of wall charts shall be included within the O & M manual.

2.33.1 Access Panels

Mark-up on drawings positions of all ceiling tiles and other panels where access is required, for commissioning and maintenance, of items such as valves, drain cocks, stop cocks, trapping sets, controls, pressure switches, motors dampers and test points. Provide and fix to the outside surface of all access ceiling tile and enclosure panels, both hinged and demountable patterns, raised coloured discs or squares indicating the location of items of equipment.
The coloured identification, means of fixing and display and charting for each individual location, shall be as agreed for the installation as a whole.

2.33.2 Fire Damper Labels and Schedule

All fire dampers forming part of the installations shall be provided with permanent and approved labels fixed securely in an agreed manner to each fire damper. The damper reference numbers shall be engraved or stamped in plain block letters on the labels. Self-adhesive labels shall not be used.
All fire dampers forming part of the installations shall be visually inspected, drop tested with the results recorded on a fire damper inspection/drop test results report. All dampers shall be provided with a reference number and the identifying number associated with each and every fire damper shall be recorded on the "Record" drawings. A corresponding fire damper schedule and inspection/drop test results report shall be provided and included within the operation and maintenance manual. The fire damper schedule shall clearly identify the reference number of each fire damper, its service, location and function. The schedule shall also include the results of the fire damper drop test carried out on each and every damper. Refer to the testing and commissioning Section for further details of the inspection/drop test procedure.

2.33.3 Valve Labels, Schedules & Charts

All valves forming part of the installations (except valves on heaters, pipe coils, branch circuits in rooms and draw-off branches in rooms where the circuits are obvious) shall be provided with permanent and approved labels fixed securely in an agreed manner on to the valves. The pipeline and valve reference numbers shall be engraved or stamped in plain block letters on the labels. Self- adhesive labels shall not be used.
In addition to reference labelling for commissioning valves, a commissioning valve schedule shall be provided listing the location of the valve and including all corresponding commissioning valve settings. A copy of the commissioning valve schedule shall be included within the operation and maintenance manual.
35mm diameter engraved metal or plastic identification discs shall be securely attached to each valve using chains to each valve.
The identifying number associated with each and every valve shall be recorded on the "Record" drawings.
Within each Plant Room and Tank Room a framed, laminated valve chart and corresponding framed, laminated schematic drawing

shall be provided and fixed to a suitable wall within it's respective area. Each chart and schematic shall be of a suitable size to enable easy reading and presented as a framed, laminated document to prevent dirt and moisture ingress. The valve chart shall clearly identify the reference number of each valve, the service and the function.
Unless specified otherwise elsewhere, all valves within services risers shall be provided with valve identification discs identified with its corresponding service type i.e. HWS-F, HWS-R etc. A copy of all valve charts and schematics shall be included within the O & M manual.

2.33.4 Pressure Systems Safety Regulations

All pressurised systems shall be supplied and installed in full compliance with the pressure systems safety regulations. A valid pressure test certificate (PED) together with a manufacturers letter of conformity shall be supplied with all safety valves. These shall state the system working pressure, set pressure and date of testing. Each certificate shall be laminated and fixed to the wall adjacent to the corresponding valve.
On completion of the installation, the Contractor shall provide to the Client's insurance company all information on system expansion vessels as is required under the pressure systems safety regulations.
The contractor shall obtain from the insurance company, a certificate for the completed installation. This certificate shall also be laminated and fixed to the wall within the plant room. A further copy of all pressure test certificates shall be provided within each copy of the O & M manual.

2.33.5 Manufacturers' Labels

All mechanical and electrical equipment and plant (other than minor items) shall bear the manufacturer's name, together with any particulars required for its identification for the supply of spares and for its duty. The information may be either cast on, or stamped on to a plate securely fixed to the plant.

2.33.6 Plant & Equipment Labels

All mechanical plant and equipment shall, in addition to manufacturer's labels, be permanently and clearly uniquely labelled with identification name, reference number and function in the shown on the "Record" drawings.
All specified electrical plant and equipment fixed or handed to others for fixing shall be suitably and clearly labelled with identification name, reference number and function in the particular installation. Thermostats and all other equipment with adjustable settings shall have, in addition on the label, their normal or range of plain block letters, shall be fixed by suitable screws or nuts and bolts, to the wall adjacent. Direct fixing to plant items shall not be undertaken unless prior acceptance is given by the Engineer. In all cases, it is the installers' responsibility to check the suitability of plant items for direct fixing of labels. Where it is more convenient to do so, e.g. for small electrical equipment, printed wall charts, giving any of the above information shall be fixed in convenient and logical position(s) and the plant or equipment labels only consist of a reference number.
The labelling shall follow the system used on scheme drawings and schedules. Identification names, reference numbers, shall be shown on the "Record" drawings.

2.33.7 Hazard Warning Signs

The Installer shall provide and fix hazard warning signs on any services below 2.0m headroom within designated access or escape routes in plant rooms or access voids. The hazard warning signs shall be either painted yellow and black at 45° or purpose manufactured tape. The Installer shall seek the Engineers comments as to where and how the signs should be erected.
The Installer shall install warning signs adjacent to each item of machinery, which is subject to automatic stop and start control. The format and material of construction of the label shall be agreed with the Engineers. The wording shall be:
DANGER THIS EQUIPMENT MAY START WITHOUT WARNING. ISOLATE ELECTRICAL SUPPLY BEFORE WORKING ON THE PLANT.
Provide and fix warning notices by the discharge pipe outlets from all temperature and pressure vent and overflow pipes, to warn of the particular danger.
DANGER WITHOUT WARNING HOT LIQUID/STEAM COULD BE DISCHARGED FROM THIS PIPE
Provide and fix warning notices by the discharge outlet from all taps providing non-mixed temperature hot water (i.e. water above 41°C) to warn of the particular scalding danger.
CAUTION HOT WATER - RISK OF SCALDING
Other labels Drinking water All mains cold-water (potable) tap outlets shall have a melamine or anodised aluminium label marked "DRINKING WATER" in 7mm high letters, permanently fixed above the outlet.

2.33.8 Stop Cocks

All mains cold-water services stopcocks shall have a melamine or anodised aluminium label marked "STOP COCK" in 7mm high letters, permanently fixed above the valve.

2.33.9 Main Gas Isolation Valve

All main gas isolation valves shall have a melamine or anodised aluminium label marked "GAS ISOLATION VALVE" in 7mm high letters, permanently fixed above the valve.

2.33.10 Emergency Shut-off

All emergency shut off valves and associated knock off button(s) shall be clearly labelled and positioned in agreed location adjacent to the operating device. Text characters for emergency shut-off labels shall be in 12mm high black lettering on a red background for “Power shut-off”, yellow ochre for “Gas shut-off” and blue for “Water shut-off”.

2.33.11 Remote Discharges

Where an overflow, warning pipe, condensate and safety valve discharges are piped remotely from the source, a label shall be permanently fixed stating the type of discharge and from where it’s source begins. Labels shall be in 12mm high black lettering on a white background.

2.33.12 Label Samples

Provide a sample of all label types to the Engineer for acceptance prior to placing of label orders.

2.34 Commissioning

The Contractor shall carry out all the testing and commissioning of the systems included within the scope of the works contract. Witnessing of satisfactory tests by the Client's representatives shall not be taken as acceptance by the Client that the responsibilities under the Contract have been fully discharged. Such acceptance shall solely be given by the Client's signature to the Certificate of Practical Completion.
Include all associated electrical and automatic control systems in the performance testing and continuous system operation tests of completed installations.
The works described by this specification includes:
1) Works prior to commissioning including progress testing: Throughout the progress of the works, carry out all necessary inspections and tests to assure the quality and performance of the installations. Provide a responsible member of supervisory staff to witness and record all such tests.
Retain copies of test certificates on site during the works, and show to the Engineer on request. Incorporate the test certificates in the Record Documents. Ensure that where installations are required to be insulated, satisfactory pressure tests are carried out and witnessed prior to application of the insulation.
2) Setting to work and commissioning all air and water systems to meet the specified flow rates as detailed in the Particular Specification and Equipment Schedules.
3) Performance testing and continuous system operation tests of completed installations, including their associated electrical and automatic control systems.
4) Additional Tests: Incorporation of additional tests at site or at the Contractor's or manufacturer's or supplier's premises, as instructed by the Engineer, on all or any of the plant and equipment intended to be used in the Contract works in any manner he/she may deem necessary to demonstrate conformity with the Specification.
The results of such test or any other test shall in no way relieve the Contractor of his responsibilities to ensure that all plant and equipment installed in the Contract works are entirely suitable for the applications and conditions of operations.

2.34.1 General Requirements

Provision of all labour, apparatus, instruments, materials, tools, plant and equipment, including steps, ladders, and scaffolding required to carry out and record the following activities:

1) Checking of Construction issue/Working Installation Drawings and confirm suitability of installations for commissioning.
2) Inspections during construction.
3) Static testing.
4) Flushing and venting.
5) Pre-commissioning checks.

Extension of warranties such that all items of plant and equipment are provided with warranties that commence from the date of Practical Completion of the Contract. Liaison/co-ordination with other Contractors and the manufacturers and suppliers during commissioning of the following specialist equipment:

1) Boilers (heating and direct fired or electric water heaters).
2) Automatic Control Systems/Building Management Systems
3) Water treatment system
4) Chillers and condenser units.
5) LTHW Heating and chilled water pressurisation units.
6) Air handling units including individual fan sets etc.
7) Passive ventilation equipment.
8) Pool equipment.
9) Fan coil units.
10) Cold water booster sets.
11) Sprinkler valve sets.

Co-ordination with the Contractors associated with the following packages who are directly responsible for testing and commissioning of these package works:

1) Lift package.
2) Security & data.
3) Electrical services inc. lighting and small power.
4) Fire alarm system.

Setting to work, commissioning, balancing and performance testing of all mechanical and associated electrical systems shown on tender drawings and described in the Technical Specification, including as appropriate, those listed below and described in performance testing section of this Specification, together with any associated electrical and automatic control systems:
1) LTHW heating system.
2) Domestic hot and cold water systems and associated plant.
3) Mechanical ventilation supply and extract systems.
4) Passive ventilation system(s).
5) Air conditioning systems. Preparation and issue of commissioning documentation. Testing of noise and vibration levels.

Environmental checks.

Definitions The following definitions shall apply to the activities associated with commissioning of the works:

a) Pre-Commissioning Checks Pre-commissioning is the phase of work which takes into account the activities necessary to advance and installation from static completion to the dynamic commissioning phase.

b) Commissioning In accordance with the Commissioning Codes, commissioning is defined as the 'advancement of an installation from static completion to full working order to specified requirements'. Commissioning includes the setting to work and regulation of an installation. Commissioning is deemed to be complete when all regulation work is concluded.

c) Performance Testing Performance testing is the evaluation of a system which has been commissioned and is operating within the tolerances as set out Personnel Ensure that commissioning and performance testing is carried out using trained, experienced commissioning engineers, the supervising commissioning engineer having a minimum of five years experience in the commissioning and performance testing of electrical, public health and sanitary, heating, ventilating and air conditioning system installations.

Ensure that commissioning and performance testing of major items of equipment including boilers, air handling plant, control panels and thermostatic control systems is undertaken by the manufacturer's personnel. Give a minimum of ten working days notice of requirement for attendance of Manufacturer's personnel to the Engineer.

Co-ordinate and supervise the manufacturer's commissioning engineers during the commissioning and performance testing of major items of equipment.

2.34.2 Works Prior to Commissioning

Inspection during construction, Ensure that during the construction period, the necessary facilities for commissioning have been correctly installed and are accessible for commissioning and future maintenance. Note any other irregularities that could adversely affect commissioning and maintenance and report same to the Engineer. Cleanliness of mechanical services installation The Contractor shall ensure that all plant, equipment, pipework and fittings are stored in a clean, dry area prior to installation and that they are protected from damage, dust and water after installation and before handover.

Pre-commissioning Carry out pre-Commissioning on each system against specific check sheets in order to bring the plant and equipment to the stage of static completion where it is ready and safe to be set to work. Submit completed static check sheets to the Main Contractor as each system is pre-commissioned.

Ensure that all components are correctly installed. Cleanliness of air and water distribution systems is essential.

Ensure that statically complete installations are correct with regard to all details required by the Specifications and as detailed on the drawings and are clean and safe to operate.

Undertake checks in accordance with the relevant CIBSE and BSRIA Commissioning codes to ensure that appropriate system is in a satisfactory and safe condition before starting up.

Rectify all installation defects prior to commissioning, where the defect has any bearing on the commissioning of a system or systems.

Pre-commissioning checks Check that the pre-commissioning has been correctly carried out and that the individual systems are ready to be set to work and inform the Engineer when this is complete.

Defect clearance Defects found during the pre-commissioning check shall be rectified by the Contractor prior to commencing commissioning.

2.34.3 Hydraulic tests

a) Heating and domestic hot cold water pipework services Hydraulic testing shall be carried out before pipework is concealed by structures, covers, partitions, ceilings, insulation, backfilling over joints, final painting etc and where there is no danger of the water tested freezing the system.

Where no indication is given the pressure shall be at least 11⁄2 times the maximum working pressure maintained for a minimum of 1 hour without loss of pressure after dealing with any weak joints, defective fittings and pipes disclosed by the initial application of the test.

All sections of the work and joints shall be accessible for inspection and all welds shall be hammer tested.

Where the new piped services are to be connected to existing, the hydraulic tests shall be carried out on the new pipework only before it is connected to the existing pipework. The final connection to the existing pipework shall be visually inspected when the system is filled and up to working pressure and temperature. All connections between new and existing systems must be fully accessible after completion.

Connections to existing pipework shall include 1⁄4 turn isolating valves with drain cocks on the dead side of each isolating valve.

Safety valves, pressure and altitude gauges shall be effectively isolated or removed prior to the test and subsequently refitted.

Certificates for hydraulic tests on site shall be forwarded to the Engineer before thermal insulation is applied. A separate set of plans shall be kept on site to maintain accurate records of site tests, the same set may be used as for the record drawings.

b) Sprinkler pipework Sprinkler pipework hydraulic tests shall be carried out strictly in accordance with the Loss Prevention Council requirements and BS 12845 as specified in Section B5: Wet Sprinkler Installations.

c) Plant and equipment All plant and equipment installed by the Contractor shall be hydraulically pressure tested by the manufacturer to at least 1.5 times the final working pressure.

The Contractor shall ensure that where items of equipment may be damaged by being subjected to a pressure

testing, they are isolated or removed prior to testing.

All oil tanks are to be tested in accordance with the requirements of the specification section for Oil Installation and BS 799 pt 5.

Where plant, equipment and tanks are tested on site, the Contractor shall provide signed test certificates for inclusion in the Operation and Maintenance Manuals. An additional copy of the certificate shall be provided in a separate folder, under the heading of Test Certificates, for the HCC Property Management.

d) MDPE underground water mains tests MDPE water mains shall be tested in sections between isolation valves or in sections with a maximum length of 600 metres. Testing shall take place between blank flanges bolted or fused to pipe ends. Ends shall be securely strutted to withstand the test pressure.

Testing shall be carried out from the lowest point of the pipework section being tested to encourage the expulsion of air as the pipework is filled and the release of test water.

Temporary air release mechanisms shall be provided to high points of the test section if permanent air release valves do not occur in the test section.

Any exposed MDPE pipework shall be temporarily protected against rapid changes in temperature whilst testing. All testing equipment and gauges must be capable of recording 0.2 bar pressure variations.

Before filling the pipeline, air venting systems shall be opened and permanent air release valves checked. Every endeavor shall be made to remove all air from the main and the introduction of a firm foam swab ahead of the water column is permitted. The test pipeline shall be slowly charged with water to allow the escape of entrapped air and air vents closed after all air has been removed from the pipeline. The pipeline shall then be left for a period of 2 to 3 hours for temperature stabilisation.

After stabilisation, the pipework under test shall be slowly pumped up to the rated pressure (working pressure) or 11⁄2 times the maximum static head on the main whichever is the greater. It is important that the test pressure is applied at a constant rate with a sensible volume/time ratio. Once the selected maximum test pressure is reached and this pressure maintained the maximum test pressure shall be maintained for a period of 30 minutes. The maximum test pressure shall then be reduced by rapidly bleeding water from the test section to a nominal test pressure of 2 bar, at the test gauge.

The pressure gauge readings shall be recorded at 2 minute intervals for the first 10 minutes, then at 5 minute intervals for the next 20 minutes followed by 10 minute intervals for the next 60 minutes. The pressure should rise, without further pumping due to the visco-elastic nature of the MDPE pipework. The results shall be plotted, a constant rising curve, indicating a sound main. Any reduction in pressure will indicate a leak.

e) Gas installation pipework Gas installations shall be tested on completion in accordance with British gas Publication IGE/UP/1: Soundness Testing Procedures for Industrial and Commercial Gas Installations. Tests shall be carried with nitrogen or other inert gas suitable for the purpose.

The test pressure on new installations or new extensions to existing installations shall be the maximum pressure likely to occur under fault conditions, a pressure equal to one and a half times the working pressure or 50mbar, whichever is the greater. On existing installations the test pressure shall be at least to the normal working pressure.

Test periods shall be determined as described in the above document. Minimum leakage rates shall be no greater than those established using the procedures described in the above document.

Subsequent to the successful testing of the installation, it shall be put into service as described in British gas Publication IM/2 “Purging Procedures for Non-Domestic Gas Installations.”

2.34.4 Air leakage tests of ductwork and air handling units

Air leakage tests of ductwork shall be carried out in accordance with the HVAC DW 143 and the Particular Specification.

Air handling plant shall be tested at works after manufacture and where these are delivered in sections to site they shall be pressure tested to 1.5 times the working pressure after the unit is bolted together in it’s final position.

2.34.5 Filling, Flushing and Draining

General After satisfactory hydraulic testing all pipework systems shall be pre-operational cleaned with chemicals to remove debris and mill scale and to inhibit corrosion and bacterial growth.

Provide a method statement on flushing procedure to ensure that each circuit is individually flushed. Submit this procedure for approval by the Engineer.

Ensure that all air vents, solution tanks, dosing pots and large bore drain-away valves necessary for the proper dosing, venting, circulation and draining of the systems are installed and operational, and that circulating pumps are available for duty before any chemicals are introduced into the system.

The system pumps shall not be used for flushing purposes but shall use temporary high head pumps to achieve the required pipe cleaning velocities in all parts of the system.

All small bore valves, control valves and heat exchangers, such as fan convectors, shall be excluded from the chemical cleaning by blanking off. By-pass loops and temporary valves shall be included to achieve the required flushing and chemical cleaning operation.

Implement procedures to ensure that all residual chemical deposits are removed from the system prior to commissioning, when chemical cleaning is applied.

Remove and clean all strainers, during and after flushing and immediately prior to balancing of the system.

Provide advance notice, of an agreed duration, to the Engineer prior to removal and cleaning of strainers.

Continue flushing and cleaning of hydraulic systems to the minimum standard as described below, until it can be demonstrated that the systems have been cleared of all debris and contaminating matter prior to refilling the system and adding an appropriate corrosion inhibitor.
Dispose of flushing water in an approved manner as rapidly as possible through adequately sized drain valves, before the systems, are refilled, and pre-operation cleaned as necessary and put into service.
Do not leave hydraulic systems empty once the chemical cleaning and flushing procedures have been completed. Take adequate precautions to prevent systems from freezing.
Take precautions to ensure that polluting matter, solid

~~2.34.6 Sampling~~

~~The Contractor shall allow for water testing as requested in Section 1.4 of BSRIA Application Guide 1/2001.1 and as specified below~~
~~One month prior to filling/pressure testing a water treatment specialist is to sample the supply water and submit to an independent laboratory to be tested for TVC, Pseudomonas and nitrite reducing bacteria (3 week test period). Test results should be checked against Table 2 within BSRIA AG 1/2001.1 and action taken as stated therein.~~
~~Closed systems containing water without use for a period exceeding two weeks, shall be sampled and tested for Total Viable Counts (TVC), Pseudomonas and nitrite reducing bacteria (3 week test period). This sampling shall be carried out at least one week before the commencement of dynamic flushing.~~
~~On completion of the chemical clean, and after the final fill and addition of corrosion inhibitor and biocide, the closed system water is to be tested for Full Chemical Analysis.~~
~~Tests to include total alkalinity, chloride, sulphate, TDS, suspended solids, pH, soluble and total iron and inhibitor levels. All results should conform to the requirements of BSRIA AG 1/2001.1~~
~~One week after completion of the system clean and final dosing, samples shall be taken from representative system extremities and low points and tested for Full Differential Analysis.~~
~~Three samples are to be taken from each system, one each from the basement (lowest point), roof (highest point) and a random (midway) location.~~
~~Three days notice of all tests shall be given to the Engineer to enable him/her or his authorised Representative to be present.~~

2.34.7 Cleaning, Flushing and Chemical Treatment

Systems to be chemically cleaned (as required within the particular specification Section 3) - Cleaning and chemical treatment shall comply with the requirements of the statutory authorities and the Health and Safety Regulations and include all new installed heating and chilled water pipework systems.
The Contractor shall allow for employing a specialist firm to carry out chemical treatment process.
Prior to carrying out cleaning or chemical treatment processes the Contractor shall ensure that:

i. All foreign matter is removed.
ii. Certified pressure tests have been carried out in the parts of the system to be cleaned.
iii. If there is to be a delay of more than 48 hours between pressure testing and the start of the cleaning process, the closed systems are to be left full of biocide dosed water.
iv. Once filled, the pipework installations shall not be drained down completely, as their inner surfaces will be prone to accelerated corrosion and bacteriological contamination. Should the period between pressure testing and commencement of dynamic flushing be greater than seven days, then system water is to be inhibited Mains water is to be provided in the plant room adjacent to main circulating pumps with a minimum valved connection size (as detailed in the table below) via a double check valve:

System Volume (L)	Minimum Main Size (mm)
<2,000	25
2,000 – 10,000	40
>10,000	50

vi. A minimum pressure of 1.3 Bar shall be provided to the highest point of the system and must be demonstrated and proven to all parts of the systems and all valves other than those used to isolate sections, are fully open.
vii. All system circulating pumps shall be fully operational throughout the process without interruption.
viii. The Contractor must ensure that all small bore control devices, air to water heat exchangers are either removed, bridged or bypassed and no damage occurs to any item of plant or equipment due to cleaning and chemical processes.
ix. Chemicals used are compatible with system materials.
x. All 'dead legs' greater than two metres in length are to be cross connected between the flow and return terminations to ensure adequate circulation of water is maintained during the cleaning process.
xi. Drain cocks are installed coil-side of unit isolation valve to allow back flushing of terminal units to take place.
xii. All 3- or 4-port valves are live or fixed in the 'open' position.
xiii. Adequate means of access is to be provided to the pipework systems during the process and continuity of the works. All valves and flushing points must be fully exposed for the duration of cleaning works. The Contractor shall allow for removal and replacement of access panels and ceiling tiles as appropriate.
xiv. All foul drains to be used for draining the pipework systems, shall have been tested and approved adequate. Approval should be sought that the drains are suitable for the chemicals used and any pumping equipment associated with the drainage system is fully commissioned.
xv. Suitable drainage points are provided with valved 50mm minimum connections, properly sited and installed.
xvi. All automatic and manual air vents are fully commissioned.
xvii. An approved manual dosing pot is to be installed on the LPHW system as manufactured by Goodwater Ltd (Tel: 0118 973 5003) or equal and approved.
xviii. All requirements of COSHH regulations are complied with during the chemical cleaning and chemical treatment of the system.
The Contractor's Specialist shall carry out tests during the progress of the works to ensure that cleaning and chemical treatment processes are operating as required. These test results shall be submitted the Engineer for approval.

2.34.7 Dynamic Flushing

The Specialist shall use raw mains water for flushing. Permanent system pumps, both run-and-standby, are to be used during this process, which have been commissioned and proven to achieve 110% of design velocity.
The initial velocity flush is carried out to remove solid matter from the system(s) in preparation for chemical cleaning. This is to be achieved by circulating and flushing in sections, as small a section of pipework as possible, using all available flushing points equally. It is the responsibility of the Contractor to ensure that the relevant flow rates are achieved. Strainers should be checked and cleaned periodically throughout this exercise.
When all samples drawn from the system are visibly clear and free from solids, the initial flush will be deemed complete.
Chemical cleaning shall commence immediately on completion of flushing or the system shall be filled with the addition of an inhibitor.
Chemical cleaning The Engineer shall be invited to witness chemical cleaning and the extent of witnessing agreed between all parties before commencement.
Upon completion of the flushing process, the Contractor's Specialist shall introduce the chemical cleaning compound into each system and circulate the chemical around the system. Chemicals shall be introduced using the aforementioned chemical dosing pots.
The cleaning agent shall be circulated around the system for a minimum period of 48 hours using permanent system pumps.
An approved preliminary cleaning agent and a degreasing chemical shall be used.
During circulation the Contractor's Specialist shall take samples to determine cleaning progress and flush debris to drain with raw mains water, purge dirt pockets, clean all filters and strainers.
This shall be carried out using the same procedure as adopted during dynamic flushing.
The Contractor shall reinstate all equipment isolated/disconnected/bypassed during the cleaning process. The Water Treatment Specialist shall remove sediment within the equipment by flushing and back flushing to drain with fresh clean water. Ensure that the operation of reinstatement is carried out as quickly as possible to prevent re-corrosion of the main pipework system.
When all units are flushed, tests should be carried out on random samples to indicate that water quality is acceptable within the following concentrations from all flushing points:

i. Total Dissolved Solids - Equivalent to incoming fresh water.
ii. pH - Equivalent to incoming fresh water.

iii. Iron in Solution - Below 5ppm or equivalent to fresh incoming water, whichever is the greater.

iv. Water Quality - Visually clear, bright and free from suspended solids.

The above reading shall be witnessed by the Engineer for acceptance before signing the completion certificates.

Immediately upon completion of the flushing/cleaning/flushing programme, Corrotreat 432 (or 422 when aluminium components are present) should be added to the system at a dose rate of 1⁄2%. Biocide 515 should be added at a rate of 1⁄2L per 1000L to prevent microbiological contamination. Chemicals are as manufactured by Goodwater Ltd (Tel:0118 973 5003) or equal and approved.

Treatment up to system handover If the building is not to be occupied or put into normal operation for a prolonged period i.e.; more than one week, then the system water shall be regularly monitored, circulated and chemically tested up to Practical Completion as described below by a water treatment specialist:

i. The water is to be continuously circulated using system pumps.

ii. Weekly sampling of closed system water for BSRIA Microbiological Analysis. Recommendations and treatment highlighted by this analysis to be put into place immediately.

iii. Weekly sampling of closed system water for on site chemistry testing including pH, iron, TDS, inhibitor levels and appearance. Dose appropriate quantities of corrosion inhibitor and biocide.

2.34.8 Cleaning and Chlorination

All new and altered domestic hot and cold water systems shall be cleaned and chlorinated in accordance with BS 6700.

Chlorination certificates shall be included in the Operation and Maintenance manuals for all hot & cold water services. An additional copy of the certificate shall be provided in a separate folder, under the heading of Test Certificates, for the Term Maintenance Contractor.

A Certificate of Chlorination/Bacteriological test shall be included in the O & M Manual.

An additional copy of the certificate shall be provided in a separate folder, under the heading of Test Certificates, for the Term Maintenance Contractor.

Ductwork ventilation systems Ensure that all ventilation systems are completely clear of any obstructions, debris and superfluous matter prior to commissioning. Secure all fire dampers in the open positions and ensure that all access covers are secured in position.

2.34.9 Commissioning and Records

Commission all of the systems as detailed on the drawings and in the Particular specification and Schedules of Equipment and agree a logical commissioning programme, prior to commencement of the work. Update and amend the commissioning programme as and when necessary.

Submit a commissioning method statement for each type of system to be commissioned. Balance all air and hydraulic systems to within the tolerances detailed in the Specification, Commissioning Codes and Guides.

Ensure that all distribution systems are balanced with due regard to noise generation. Provide all relevant information to the Engineer where system noise exceeds the acceptance levels specified.

Record and submit as commissioning records all measurements and operational details as commissioning work proceeds.

Clearly mark all air distribution system dampers in an approved manner when the individual system has been balanced. Lock and indelibly mark all dampers in their final regulated positions in an approved manner.

Lock all double regulating valves in their final regulated positions in an approved manner. Record the final regulated position of all hydraulic regulating devices and submit as part of the Commissioning Records.

Demonstrate the final balance of all air and hydraulic systems to the Engineer.

Submit the Commissioning Records and certify that the results are within the allowed tolerances. Do not proceed with system performance tests until the certified records have been submitted and accepted in writing.

2.34.10 Standards

Carry out the commissioning strictly in accordance with the recommendations of the Chartered Institution of Building Service Engineers and The Building Service Research and Information Association as listed above.

Where it is not possible to exactly follow the aforementioned codes, prepare and submit an alternative procedure and issue to the Engineer for approval prior to the commencement of commissioning.

2.34.11 Commissioning Documentation

As soon as plant and equipment has been placed on order, prepare the Commissioning Documentation, including, but not limited to:

1) Systems Specification.

2) Working Drawing.

3) Functions Schematic Diagrams.

4) Wiring Diagrams.

5) Control System Diagrams, Set Points and Schedules.

6) Works Test Certificates and Performance Curves.

Prepare a commissioning document containing all the check and test sheets necessary for the correct checking, balancing testing and witnessing of each individual system and major plant item.

Reproduce the document containing an index and progress chart, issue to the Engineer at agreed intervals, representative of the whole installation programme to indicate the commissioning progress.

2.34.12 Submission and Certification of Records

Submit two complete sets of data on all equipment and systems to be commissioned on A3 and/or A4 size paper as required and in the form agreed with the Engineer before submission, to show the design figures and the final operating values at which the systems and equipment were set. Record the settings of all dampers and controls, etc.

Ensure that all records and submitted data are dated, uniquely numbered and clearly referenced to the time tested by means of serial, chassis, or other manufacturer's reference number permanently marked in a conspicuous position on the item concerned. Also, ensure that the "unique" numbering system cross references with the numbering system used on the Record Drawings and Operating and Maintenance Manuals. Ensure that system/plant numbering systems are co-ordinated.

Immediately upon completion of the commissioning work, submit the following:

1) Schedules of air terminal volumes, with each fan system detailed on a separate sheet.
2) Schedules of fan details and duties obtained, electrical current consumed, full load current, speed and characteristic curve with site performance point clearly marked after pulleys and belts have been changed to meet design values.
3) Schedules of pump details and duties obtained, current consumed, full load current, speed and characteristic curve with site performance points clearly marked after any modification or change to pulleys, belts or impellers.
4) Schedules of all regulating valves, flow rates and settings.
5) Schedules of electrical equipment application types, full load current and overload settings.
6) Schedules of automatic control settings.
7) Schedules of all venturi meters and orifice plates with flow rates.
8) Schedules for all other items of plant or mechanical systems.

Ensure that all items included in the schedule are uniquely numbered and cross referenced to the Record Drawings and Operating and Maintenance Manuals.

2.34.13 Setting to Work

On completion of defect clearance and with power available set to work the individual systems. Ensure that the Installer of the plant power distribution and automatic controls systems are in attendance during the setting to work of all motor drives and major plant.

Do not leave plant running unless all parties agree that it will be safe to do so.

Initial plant checks As soon as a system has been set to work, carry out an initial plant test to establish the volumetric flow rate relative to the design. Should the initial test indicate a deviation from the design requirement of more than -5% to +20%, investigate the reason and report findings to the Engineer with recommendations for remedial action. Unless authorised by the Engineer do not attempt to balance any system where the initial tests indicate a deviation from the design of more than -10% to +20%.

Pre-balancing inspection Carry out a pre-balancing inspection to ensure that all defects noted during the precommissioning checks have be corrected. Notify any defect found to be still outstanding to the Engineer.

Balancing Proportionally balance the fluid flow rates in each Air and Water Distribution System, within the tolerance specified by the CIBSE and BSRIA Commissioning Codes. Do not 'force' the individual branches or terminals into balance at the expense of total plant performance or noise. Where a high resistance is found in any part of the system that is adversely affecting the proportional balance, investigate the cause and advise the Engineer with recommendations for possible remedial action.

Final plant checks On completion of satisfactory proportional balancing, carry out a final plant test to establish the performance of the pump/fan relative design. Where the final plant test indicates a deviation from design of more than + or -5% advise the Engineer and give recommendations for remedial action.

Specialist plant commissioning With the correct fluid flow rates in the air and water systems ensure that the specialist plant commissioning is carried out by the manufacturers or suppliers. Liaise with the manufacturers or suppliers to ensure the correct and effective commissioning of the specialist plant items.

Obtain from the manufacturers or suppliers the test certificates for the specialist plant item and include in the commissioning documentation.

2.34.14 Plant Thermal Checks

Carry out plant thermal capacity checks.

2.34.15 Environmental Checks

Carry out environmental checks with attendance from the Automatic Controls Specialist Contractor. Carry out checks and adjustments to ensure the specified conditions of temperature, relative humidity and the air movement are achieved in each space. sound level checks in each space using a simple dbA weighted meter. Where the sound level in any space exceeds the specification, repeat the test with an instrument capable of octave band analysis and present the results plotted against NR curves, together with a report to the Engineer on the possible cause and suggested remedial action.The sound pressure levels measured in one octave bands shall be measured 1500mm above the floor in three locations in the rooms listed in the Schedule with the mechanical service operating and without the mechanical services in operation to establish the noise level due to the services with the plant running at maximum speed and at minimum speed.
All measurements shall be made with a recognised make of instrument, which has been recently calibrated and by a person experienced with such measurements.
Sound level meters shall conform to the requirements of BS EN 61260 Type 1, available with octave band and third octave band filter sets as necessary complying with BS EN 60651.
Advise the Engineer of the details of the equipment intended for use in addition to the above and other test details.

2.34.16 Witnessing

Demonstrate the commissioning and test results obtained to the Engineer or his representative. Ensure that the witnessing of test results occurs on a progressive basis and left until all systems are completed.
Offer individual systems for witnessing by the issue to the Engineer of relevant test sheets complete with a signed certificate declaring the test results to be a true and accurate record. All test results thus presented will be witnessed within seven days of receipt by the Engineer.
Witness records The contractor is to liaise and agree the amount of witnessing required with the Engineer prior to contract. A Witnessing Record Schedules shall be introduced ahead of any testing to determine the extent of witnessing required and the amount of systems offered.
The extent of witnessing to be carried out by the Engineer and/or his representative shall be agreed at the time of Tender but shall not be less than the Record Schedule reproduced in the Project Appendices.

2.34.17 Performance Tests

a) Performance testing HVAC systems
Carry out performance tests as detailed in the Particular specification and/or Equipment & System Schedules.
Positions of test instruments including a comprehensive temporary installation of portable recorders to simultaneously record temperature and humidity measurements for summer and winter conditions shall be agreed with the Engineer.
b) Boiler Combustion Efficiency
For boilers up to and including 600KW rating, base combustion efficiency calculations on flue gas loss, taken at the flue connection of each boilers. Supervise the commissioning of the boilers carried out by the manufacturer.
c) Ventilation Systems
The Contractor shall start up, commission and test all equipment and systems to performance as specified, recording the design values and measured values
The drive alignment and the degree of vibration transmission shall be checked to ensure that it is satisfactory.
The air flow from each outlet and into each air intake shall be measured by use of calibrated hood with an inbuilt anemometer.
All flow rates shall be adjusted to within +10% to -0% of the design flow rate.
The Contractor shall allow for one pulley change based on the initial measurements.
The pressure drop across the following shall be measured:

1) Clean air filters.
2) Heating coils.
3) Cooling coils.

The pressure rise across all fans shall be measured together with the temperature rise of the air across all heating coils with full flow of heating water at 80°C through the coil.
The water flow rate through each coil shall be measured by the commissioning set flow measuring valve.
The flow rates shall be adjustable to +10% to -0% of the design flow rate by the commissioning sets.
The following air flow rates shall be measured for each of the systems:
Minimum outside air flow rate on mixing/recirculation systems +10% to –0%:

1) The return air flow rate with the minimum outside air flow rate.
2) The exhaust flow rate from each system.
3) The system flow rate when supplying all outside air and minimum outside air.

4) The airflow rate in each of the main and branch ducts.

5) The air flow rate at each terminal device.

Supply and install test points on ductwork and air handling unit casing as necessary to take measurements specified. Provide removable cover over test points. Label all test points with engraved plastic label screw fixed adjacent to the test point.

d) Boiler Plant

Measure and record the following for all heating boilers and direct fired HWS generators:

1) Gas pressure before each burner with all items of gas fitted equipment operating.

2) The gas flow to each burner. Run each item separately and record flow rate on gas meter.

3) Flue gas CO_2 and temperature.

4) Flue gas draught pressure with one burner only operating and with all burners operating.

When measuring heating boiler performance record the outside air temperature, heating water flow and return water temperatures and under floor heating floor coil water flow and return.

e) Under Floor Heating Commissioning, Balancing and Start-up

This may vary between systems, but the basic steps shall be:

1) flush and clean system as detailed elsewhere and fill all pipework with water.

2) purge all air from the system.

3) operate the under floor heating system pumps.

4) balance the circuit valves to the design flow rates.

5) switch on the heat source.

6) raise the system temperature – this shall be carried out slowly to avoid excessive drying out of the flooring, typically by increasing the water temperature in the system by approximately 5°C per day, starting from a temperature of 25°C or 15°C above the temperature of the unheated floor screed, whichever is the higher. During this period the system shall operate 24 h per day if the weather compensation controls are functional throughout.

7) check the temperature drop across each circuit and rebalance if necessary.

8) check the correct operation of the control system This shall include checking the correct operation of all control valves, thermostats, actuators, time control devices including the night set- back function, and outside weather compensation devices.

9) check the flow and return temperatures.

10) check room temperatures.

11) produce the commissioning report.

12) check working drawings, modify as necessary and produce a detailed set of record drawings.

f) Water systems All measurements of water flow shall be initially made with all valves fully open. The system shall then be balanced by setting each of the DRV to the commissioning sets to the specified flow rate.

Measure and record the following:

A – Flow Rates: 1) The system flow rate.

2) The flow rate to each item of equipment.

3) The flow rate at each commissioning set.

4) The floor temperature of an underfloor heating system shall be measured in four (4) nominated locations for each zone after the system has been operating for not less than one week with an external air temperature not exceeding 5°C.

5) Check the operation of each control valve and room thermostat on the underfloor coil circuits.

6) Check the operation of the differential pressure control valves to ensure that the maximum differential is not exceeded.

B - Pressures at all pumps:

1) Suction.

2) Discharge.

3) Selected pump speed.

C - Hot water:

C1) Supply and circulation return temperatures from the gas fired hot water boilers.

C2) Manual adjustment shall be key operated only to give the following discharge temperatures:

Residential and Nursing Care Homes:

Residents wash hand basins	41°C
Staff wash hand basins	43°C
Assisted and unassisted baths	44°C
Sluice rooms sinks	46°C max.

Schools & Colleges etc:

Classroom Wash hand basins	43°C
Classroom sinks	43°C max.

All Buildings:

Wash hand basins	43°C
Showers	41°C
Bidet	38°C

Note 1: On completion of commissioning, all strainers shall be re-checked and cleaned to remove any disturbed contaminates.
Note 2: For higher temperatures a risk assessment shall be completed and when approved by the Engineer "Caution Hot Water" warning label must be permanently fixed immediately above the respective hot tap.
Note 3: Pot wash sinks installed in commercial & school kitchens which are secure areas where the public, home residents and school pupils are not allowed, the hot water outlets shall not be fitted with TMVs but shall be fitted with approved "Caution Hot Water" labels. D Flow and return temperatures from all chillers, boilers and water heaters:
A copy of all of the measured temperatures, dated and with all mixing valves referenced shall be included in the O & M manuals. An additional copy of the certificate shall be provided in a separate folder, under the heading of Test Certificates, for the Term Maintenance Contractor.

2.34.18 Room Conditions

Measure the room air temperature and humidity in the building at ten locations 1500mm above floor level at hourly intervals over a period of ten hours. The locations shall be agreed with Engineer prior to commencing.

2.34.19 Miscellaneous

The full load electrical current drawn by each power item of equipment shall be measured and recorded.

2.34.20 Plant Room Schedules and Schematics

Provide and frame the following under glass and hang in each plantroom and any other appropriate location:

1) Circuit diagrams consisting of schematic drawings of circuit layouts showing identification and duties of equipment, numbers and locations, control and circuits.
2) Valve schedules in the form of typewritten or stencilled sheets showing the number, type, location, application/service and symbol, and normal operating position of each valve installed.
3) Control schematics.
4) Mechanical plant schedules.
5) First aid instructions for treatment of persons after electric shock.
6) Notices or other items required under Statutory or other obligations.
7) Location of main incoming gas valve serving gas meter.
8) Location of sprinkler fire main control valve.
9) Emergency operating procedures and telephone numbers to be used during an emergency.

2.34.21 Recording

The results of all commissioning and testing and recordings of all measurements shall be submitted to the Engineer in a tabular form before the date of Practical Completion, except if conditions are not appropriate when the outstanding testing shall be carried out as soon as practical after Practical Completion at an agreed date and time.
At least seven days prior notification of any and all tests shall be given by the Contractor to enable the tests to be witnessed by the Engineer or his/her representative. The Contractor shall if necessary, depending on the results of the testing, make further adjustments followed by further tests to verify the documented performance.
If the Engineer is called to site by the Contractor to witness tests and system operations which are found to be incomplete or it is not possible to carry out, the cost of the visit by the Engineer may be charged to the Contractor. Valve schedules Individual, fully detailed valve schedules shall be produced for the following valve types to enable an effective program of maintenance to be implemented:

1) Commissioning sets.
2) Thermostatic mixing valves (TMV).
3) Thermostatic radiator valves (TRV).
4) RPZ valves.
5) Safety valves.

All valve schedules shall include the test data recorded at commissioning e.g. valve wheel settings, TRV settings etc.

2.34.22 Valve Charts

A copy of all valve charts and corresponding schematics produced (refer to Identification & Labelling) shall be included within the O & M manual and fixed in a prominent position in the respective plant room.
The schematic shall be plastic laminated and shall show the date the diagram was prepared.

2.34.23 Gas Diagram

An A3 size gas schematic diagram shall be fixed to the wall adjacent to the primary gas meter. Full details of all meter, sub-meters, gas appliances, pipework routes, valves, control arrangements etc. carried out shall be included.
Where dealing with an existing building, there should already be a gas schematic of the current installations. Allowance must be made to either update the existing or completely redraw the gas arrangement to reflect a true and accurate record of all gas installations on the site.
Where works to the incoming gas pipework from the site boundary to the gas meter(s) is undertaken. A record drawing (to suitable scale) shall be produced (or existing drawing updated) showing all works undertaken to reflect a true and accurate record of all gas installations on the site.
A copy of all drawings relating to the gas installations shall be included in the O & M manual.

2.34.23 Pressure Systems Safety Regulations

All pressurised systems shall be supplied and installed in full compliance with the pressure systems safety regulations. A valid pressure test certificate (PED) together with a manufacturers letter of conformity shall be supplied with all safety valves. These shall state the system working pressure, set pressure and date of testing. Each certificate shall be laminated and fixed to the wall adjacent to the corresponding valve.
On completion of the installation, the Contractor shall provide to the Client's insurance company all information on system expansion vessels as is required under the pressure systems safety regulations.
The contractor shall obtain from the insurance company, a certificate for the completed installation. This certificate shall also be laminated and fixed to the wall within the plant room.
A further copy of all pressure test certificates shall be provided within each copy of the O & M manual.
A written scheme for working on the vessel(s) shall also be provided in the O & M manual.

~~2.34.20 Performance Test Schedules~~

~~The following schedules are indicative of the information required during performance testing and represent the absolute minimum requirement, which is likely to be exceeded.~~
~~Make due allowance in the tender for this likelihood.~~
~~a) Boilers for LTHW heating and DHWS systems~~
~~The following to be measured and recorded on the schedules complete with the date and time of when the measurements where taken:~~

~~1) outside air temperature. 2) flow temperature. 3) return temperature. 4) boiler back end protection diverting valve opening & closing temperatures. 5) flow and return temperatures for any: i. Variable temperature circuit. ii. Constant temperature circuit. iii. HWS primary circuit. iv. HWS secondary circuits.~~

~~Calculated boiler efficiency for each boiler based upon fuel consumed and heat output measured.~~
~~b) Refrigeration plant and fan coil units (FCU)~~

~~1) FCU air volumes for each speed. 2) Air temperatures on and off to prove cooling duties. 3) Pressure tests of pipework distribution. 4) Control functions proving. 5) Metering accuracy proving. 6) Noise levels of condensers and FCU's at peak and night time conditions. 7) In duct and break out for FCU's or rooms limiting NR levels (NR 30 day NR 25 night) and for external condensers at 1 metre from enclosure and façade of nearest building.~~

~~c) Air distribution Systems~~

~~Provide a single line schematic of each air distribution system with the design and achieved air flow rates indicated for each section of ductwork. Provide information of each supply air handling plant and return fan as follows: 1) Design air volume and achieved air volume. 2) Design static resistance and achieved static resistance. 3) Design power absorbed and achieved power absorbed. 4) Filter resistance measured at time of test. 5) Fan Serial No. and Fig. No. 6) Fan output (kW). 7) Motor (kW). 8) Fan & motor pulley sizes. 9) Heating coils EAT and LAT °C (Dry & Wet bulb). 10) Cooler coil EAT and LAT °C (Dry & Wet bulb). 11) Heater coils – air resistance. 12) Cooler coil – air resistance. 13) Heater coils – duty kW, and where applicable hydraulic pressure drop. 14) Cooler coil – duty kW, and where applicable hydraulic pressure drop. 15) Noise levels, to atmosphere, building structure and in duct.~~
~~Test the fan of constant pressure variable air volume systems by setting all the terminal device control sensors to minimum and maximum to test and record the respective air volumes and hence at the fan. On satisfactory completion of test reset sensors to operate to the specified design requirements.~~

~~d) Fan Coil Units and Other Air Terminal Devices:~~

~~1) Volume at design (minimum and maximum as appropriate). 2) Inlet and outlet developed pressures. 3) Noise level, in duct and radiated from casing. 4) Hydraulic pressure drop of heating and/or cooling coils.~~
~~Environmental management and automatic control systems~~
~~Ensure that the automatic controls are commissioned by the Specialist Contractor in accordance with the requirements of Section B10: Automatic Controls and the Particular Specification.~~

~~e) Proving of Environmental Conditions~~

~~Provide a schedule of achieved space conditions for each area at the time of commissioning. Space conditions shall be measured at the appropriate time of year during the 12 months defects liability period. Indicate the measured space conditions in °C dry bulb.~~
~~Record the measured outside air conditions (wet and dry bulb as appropriate) at the time of these measurements.~~
~~To demonstrate that the air-conditioning systems operate correctly under various ambient conditions carry out the tests of internal temperature and humidity using suitable recording thermohydrograph(s).~~
~~Carry out a tests as agreed with the Engineer. Record the prevailing external conditions. Ensure that each test lasts for a period of seven days and that each test is carried out twice during the year after completion i.e. winter and summer conditions. Agree the exact timing and location of the test equipment with the Engineer. On completion the tests submit results to the Engineer.~~

SECTION THREE

SCHEDULES OF WORK
PARTICULAR SPECIFICATION

MECHANICAL SERVICES

SECTION 3 – SCHEDULE OF WORKS TO BE DONE & TECHNICAL SPECIFICATION

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3.0. SECTION 3 – SCHEDULE OF WORKS TO BE DONE & TECHNICAL SPECIFICATION

3.1. INTRODUCTION & SCOPE OF WORKS

The objective of this project is to undertake the alterations and extension to the existing main building reception and associated admin office, in order to create an enlarged waiting area, reception desk and additional administration office space.

All existing redundant mechanical services within the proposed works area, and all other associated & affected areas shall be carefully isolated, decommissioned, stripped back and removed from site.
This includes all existing: Hot & Cold Water Pipework, LTHW Heating, Above Ground Drainage, Ventilation Plant; Fans; Ductwork ; Grilles & Controls – and all other associated systems and mechanical services equipment.

The new installations shall be carefully planned and coordinated with the new proposed fixed furniture, loose furniture, door openings and windows, appliances, existing and proposed new / existing M&E services, building elements and structure.

All works are to be undertaken whilst the building is generally vacated by students, staff and visitors during summer holiday period.
However any work that may give rise to interruption of existing services and facilities shall be programmed in advance, and carefully planned with full liaison via the project team to ensure any out of term activities can be organised to suit.

The following elements are a general guide to the works expected to be carried out, as follows;-

- Isolation, draining, removal of existing hot & cold water services
- Isolation, removal of existing above ground drainage
- Isolation, draining, removal of existing LTHW Heating
- Isolation, removal of existing above ground drainage
- Making good of any existing disturbed services system connections – removal of unused branches, dead-legs etc and reinstatement & making good of thermal insulation including finishes and labelling etc.
- Making safe & removal of existing wall fans and controls
- Installation of new hot & cold water to new Visitor WC
- Installation of new above ground drainage to new Visitor WC
- Installation of new extract ventilation to new Visitor and Existing adjacent WC
- Removal of existing redundant radiators and pipework – and installation of new LTHW systems to remodelled areas
- Installation of new dedicated pumped CT LTHW circuit to serve over-door air-curtain heater to Main Entrance Door
- Installation of New DX Refrigeration Comfort-Cooling system to Admin Office
- The setting to work and commissioning of all new plant and equipment including any disturbed or reused/relocated existing: heating, hot & cold water, above ground drainage, ventilation, refrigeration comfort cooling, and all associated controls
- Demonstration of new plant function and system performance to the project team, and client's representatives
- All necessary certificates to demonstrate compliance where appropriate
- As-installed Manuals and Drawings

3.2. CONTRACTOR'S DESIGN

The Mechanical Sub-Contractor shall carry out a full site survey and appraisal of the existing services that are present, and the main plant, equipment, associated systems - and all relevant conditions which will be required and upon which the Contractor shall formulate his design proposal.
The Mechanical Sub-Contractor shall meet the requirements of applicable CIBSE design guides, and UK Gov. Department of Education - Schools Design Guidance, as follows:

Guidance	Name
CIBSE Guide A	Environmental Data
CIBSE Guide B0-B4	Heating, Ventilation, Air Conditioning & Refrigeration
CIBSE Guide C	Reference Data
CIBSE Guide E	Fire Safety Engineering
CIBSE Guide F	Energy Efficiency in Buildings
CIBSE Guide G	Public Health & Plumbing Engineering
Schools Design – Building Bulletin BB93	Acoustic Design of Schools Performance Standards
Schools Design – Building Bulletin BB100	Design for Fire Safety in Schools
Schools Design – Building Bulletin BB101	Ventilation, thermal comfort and indoor air quality 2018

Any contradictory requirements shall meet the School's Design specifications as an overriding priority.

The Mechanical Sub-Contractor shall assess the capacity of the existing services, and install new (or undertake modifications to existing) plant & distribution systems where the existing capacity, arrangement or location is inadequate or unsuitable, and/or as specifically required by this specification.
The Mechanical Sub-Contractor shall carry out detailed calculations to assess heat losses, heat gains, services loadings and plant capacity, etc, which shall be submitted comprehensively in full for comment along with the Contractor's design proposals.
The Mechanical Sub-Contractor shall submit his design in the form of scaled, detailed technical CAD drawings in sufficient detail to enable his design to be adequately appraised by the Engineer, to his satisfaction.
Suitable measures shall be included in the Mechanical Sub-Contractor's design for the effective prevention of legionella growth, which shall be fully implemented within his installations.
The Mechanical Sub-Contractor shall prepare a designer's risk assessment to support their designs and proposals, and specifically in respect to the safe operation, ongoing maintenance and future replacement, in full accordance with current Health and Safety Legislation.

The Mechanical Sub-Contractor's design shall adhere to the requirements under the building regulations for the conservation of energy.
Additionally, the Mechanical Sub-Contractor shall prepare and submit all necessary documentation required by the local planning authority in order to substantiate and demonstrate his design in respect to all applicable building regulations requirements for heating, ventilation, cooling, domestic water services, drainage.
This information shall be submitted along with the abovementioned design proposal information ie drawings & supporting calculations.

The Mechanical Sub-Contractor shall design systems which are quiet and efficient and conform to the specific planning requirements of the site including the boundary noise level limitations.
This information shall be sought by the Mechanical Sub-Contractor directly with the listed planning authority involved with the project.

It shall remain the Mechanical Sub-Contractor's responsibility and duty to provide all and any documentation in support of his design proposal in order to satisfy and answer all of the Client's project design team queries and questions. No materials shall be ordered or acquired prior to release of the Mechanical Sub-Contractor's proposal through satisfactory resolution of all technical points raised.

The Principal Contractor shall take the lead in determining project programming & coordination for himself and all other parties.

Name of Party	Work Element	Employed by	Managed by	Programmed & Coordinated by
Principal (Building) Contractor	All Minor & Major Specified Builder's Works	Principal Contractor	Themselves	Themselves
Mechanical Services Sub-Contractor	All works within this specification & associated drawings	Principal Contractor	Principal Contractor	Principal Contractor
Electrical Services Sub-Contractor (others)	All electrical services power supplies works	Principal Contractor	Principal Contractor	Principal Contractor

3.3. TENDER DOCUMENTS

Architectural / Building Surveyor's Information

Reference	Title	Size
19-187-PSRE-01	Extg Location Plan	A1
19-187-PSRE-02	Extg Site Plan	A1
19-187-PSRE-03	Proposed Site Setup	A1
19-187-PSRE-04	Enabling Plan	A1
19-187-PSRE-05	Demolition Plan	A1
19-187-PSRE-06	Proposed Site Plan	A1
19-187-PSRE-07	Proposed Reception	A1
19-187-PSRE-08	Proposed Administration Office	A1
19-187-PSRE-09	Proposed Link Corridors	A1
19-187-PSRE-10	Proposed Kitchen Access Corridor	A1
19-187-PSRE-11	Proposed Furniture Layout	A1
19-187-PSRE-12	Existing Elevations	A1
19-187-PSRE-13	Proposed Elevations	A1
19-187-PSRE-14	Proposed Roof Layout	A1
19-187-PSRE-15	Proposed Flooring Layout	A1

DGA Documentation

Reference	Title	Size
2007M/JH	Mechanical Services Performance Specification & Client's Requirements	A4
2007 -M01	Mechanical Services – Reception Extension - Existing (Indicative for Guidance)	A0
2007 -M02	Mechanical Services – Reception Extension – Proposed HCWS, Heating, Drainage, Ventilation, Cooling	A0

All drawings included within this tender invitation are intended to show the indicative existing installations (only Indicative for outline Guidance) and the design intent for the proposed mechanical services works.
The Mechanical Sub-Contractor shall determine all existing information from comprehensive site survey, and utilise and develop this information to provide his own 'installation' drawings as he so requires in order to comprise & demonstrate his final design solution.
Any specific dimensions or locations of existing equipment shown should not be used for critical setting-out of plant or equipment, but shall utilised as the outline basis to be further verified and developed by the Mechanical Sub-Contractor within his coordination and installation works as required.
The Mechanical Sub-Contractor shall produce his own design, fabrication and working construction drawings, which shall be presented via the Principal Contractor to the CA as part of the design proposal during the design review and assessment process.
The Mechanical Sub-Contractor's Design Proposals shall be issued along with all supporting technical calculations, including any collected third-party information and any assumptions (which shall be suitably identified as such – with suitable detailed commentary to clearly demonstrate the assessments made).

3.4. ROOM DATA SHEETS

The Mechanical Sub-Contractor shall include all Mechanical Engineering Services provisions required in order to meet the client's requirements as indicated on the following documents:-

Title	Reference	Location
DGA – Employer's Requirements – Mechanical Services : Ventilation & Cooling	RDS-M1	Section 5
DGA – Employer's Requirements – Mechanical Services : Heating	RDS-M2	Section 5
DGA – Employer's Requirements – Mechanical Services : Hot & Cold Water	RDS-M3	Section 5
DGA – Employer's Requirements – Mechanical Services : Waste & Soil Drainage	RDS-M4	Section 5

Should any conflict occur between the above documents then the higher quantity and/or the higher specification (quality/performance) shall apply.

3.5. THE CLIENT

The client is: -

Mick Wynne
Head of Service, Corporate Landlord Capital Programme
Commissioning & Commercial Services|Community Directorate
Internal: 7692
External: 020 8424 7692
BUILDING A BETTER
HARROW
www.harrow.gov.uk

3.6. THE SITE

The site address for the works: -

Pinner Park Primary School
Melbourne Avenue, Pinner, Middlesex. HA5 5TL
T: 020 8863 2191
E: office@pinnerpark.harrow.sch.uk

3.7. CONTACTS

All enquiries, either of a general or technical nature in respect of this tender shall be addressed to:-

Aaron Crown **EDGE Property Solutions** **Birmingham**	Tel 07484 080480	Email: aaron.crown@edgeps.co.uk
Joseph Matthews **EDGE Property Solutions** **Sheffield**	Tel 07990 039294	Email: joseph.matthews@edgeps.co.uk
Jon Hall, **Mechanical Engineer:** **DGA Consultants**	Tel 07976 732876	Email: office@dgace.co.uk

3.8. PROGRAMME

The key dates for the project are listed within the Main Contractor's package.

3.9. DAMAGE TO OTHER SERVICES

The Mechanical Sub-Contractor shall take great care not to damage any services not covered by this contract.
If any damage happens to arise, then the CA should be informed immediately.
The Mechanical Sub-Contractor shall make good any damage at his own expense – to the satisfaction of the CA.

<u>It is highly recommended that the Mechanical Sub-Contractor carries out his own Dilapidation Survey with sufficient photographs or similar records to illustrate any existing deficiencies or damage that could be construed as arising from this project, at a later date (this shall also include a functionality test where deemed applicable).</u>

3.10. CARE OF BUILDING FABRIC

All precautions must be taken to avoid damage to floor and wall surfaces etc. Pipework threading or soldering/brazing/welding or any other such work shall be carried out on a plywood or hardboard base and care taken that the swarf & oil from screw threading is not trodden into the floor surfaces and is contained tidily within the local area of work.
The Mechanical Sub-Contractor will be held responsible for any damage to the building fabric howsoever caused.

3.11. CRANE'AGE AND DELIVERIES

The Mechanical Sub-Contractor shall schedule all work requiring lifting of plant and equipment (including any site cabins, skips, stores, welfare facilities, etc) requiring the use of a permanent or mobile crane / lift / hoist for an agreed weekend or other 'out of normal hours' period, and at a time of day, and day of week to suit the client.
This is applicable for both deliveries and removals / carting away.
The Mechanical Sub-Contractor shall schedule all major deliveries for a day and time during a weekend, which shall not disrupt the normal use of roadways and parking areas within the School site, or Public Roadways.
Any abnormal size deliveries shall be planned with full method statements and risk assessments plus a mini-programme for submission and agreement with the Contract Administrator.
The Mechanical Sub-Contractor shall make a formal application in writing for these major deliveries and any crane'age, through the Contract Administrator, giving at least 14 calendar days notice.
Failure to plan, agree, and abide by pre-arranged deliveries and crane'age will result in cancellation of these operations, entirely at the Mechanical Sub-Contractor's expense.

3.12. BUILDER'S WORK

The Building Contractor (ie others) will be responsible for the carrying out of the major builder's work items directly and indirectly arising from these works.
The Mechanical Sub-Contractor shall however carry out all minor builder's works items associated with this project, which shall include all holes up to 28mm diameter (clearance).
The Mechanical Sub-Contractor shall also carry out the work necessary to preserve the integrity of all fire compartment demarcation elements, which shall also include fire dampers, intumescent collars, smoke seals, hole packing, gap sealing and any similar associated works.
All works of this nature shall be carried out to the satisfaction of the CA.

3.13. ASBESTOS

The client will have organised an Asbestos R&D Survey prior to commencement of the works on site, and will issue this as part of the project documents, to the Contractor.
Notwithstanding this, due to the vintage of the building, it is a possibility that ACM remain present within the construction materials originally used, including parts of the M&E services & sanitary installations.
The information contained in any Asbestos Survey should not be treated as definitive or exhaustive, and hence the Mechanical Sub-Contractor must proceed with caution and due diligence at all times.

If the Mechanical Sub-Contractor is suspicious (in advance) of Asbestos being uncovered then he shall raise his concerns with the CA in good time, and under these circumstances the testing of any suspect materials will be arranged, or be uncovered under controlled conditions by others.
If the Mechanical Sub-Contractor suspects that Asbestos has been uncovered / discovered or disturbed then he shall cease all works and vacate the area immediately – The CA shall be alerted to the incident as a matter of urgency.
All materials, outer clothing and tools shall be left in position / on site until any contamination is removed & a clearance certificate is issued.
Records of personnel involved, dates and times shall be issued to the CA and must be kept for future reference

3.14. FIRE & SMOKE INTEGRITY

The Mechanical Sub-Contractor shall carry out the work necessary (including time allowance, supply and installation of all materials including employing of a specialist sub-contractor where applicable) to maintain & preserve the integrity of all fire compartment demarcation elements where his installations cross these points. This shall include ducted fusible link fire dampers, intumescent duct & pipework collars, hole packing & sealing, gap infill & sealing, conduit & trunking stopping (including internally to containment), and any similar associated works.
Any specialist sub-contractors engaged by the Mechanical Sub-Contractor shall be suitably trained, experienced and accredited through specific license(s) for the type of work being undertaken: the specialist shall hold FIRAS certification and ASFP membership.
Where appropriate – major service route penetrations shall be given a unique reference (recorded on site via suitable label) and all information then scheduled and recorded in the Operating and Maintenance manuals & Record Drawings.
All works of this nature shall be carried out to the satisfaction of the CA.

3.15. CONSTRUCTION (DESIGN & MANAGEMENT) REGULATIONS 2015 (CDM)

A Health & Safety Consultant has been appointed to undertake the Principle Designer (PD) role, and will be a key point of contact for all Health and Safety related matters.
The PD has provided a Pre-Construction Information Document relating to this project, which is provided separately, along with this tender information package.
The PD will pass authoritative comment upon all Risk Assessments presented by the Mechanical Sub-Contractor (via the Principle Contractor ie Builder) – who will manage and be responsible for this process.

3.16. SPECIAL WORKING CONDITIONS

The existing building will not be fully occupied usage during the works although some out-of-term activities by staff, pupils and visitors may continue within the school.
It is essential that any works planned to be carried out on the existing or new building services installations do not cause unplanned disruption to existing normal service provision.
Where there it is unavoidable that an existing service requires isolation/interruption or similar, this shall only be carried out after a formal shut-down request is submitted along with supporting information – and a formal approval received.

Key SAFETY RISK points for consideration;-

*Trip and fall	*Uneven surfaces	*Working at Heights
*Noisy environment (plantrooms)	*Rotating Machinery	*Electrical Equipment
*Confined Spaces (plantrooms)	*Hot surfaces	*Live Power Cables
*Buried Services (in fabric)	*Underground services	*Exposed conditions (external)
*Occupied building	* Manual Handling	*Pressurised Systems

3.17. RISK ASSESSMENTS & METHOD STATEMENTS

The Mechanical Sub-Contractor shall prepare and present a series of risk assessments and method statements (RAMS) pertinent to each aspect of his works, in each location – and present them in good time to the CA for comment.
The RAMS shall be written specifically around the works being undertaken within this project to ensure the Mechanical Sub-Contractor has considered his works and operations carefully and in a considered manner.

Works shall not proceed until all comments on the RAMS from the project team have been satisfactorily resolved.
The RAMS shall form part of the documentation which the Mechanical Sub-Contractor shall use to brief and instruct his operatives on site.

3.18. ELECTRICAL WORKS

The Electrical Services mains power wiring installations will be carried out by the Electrical Contractor ie Others. The Mechanical Sub-Contractor shall be responsible for briefing the Electrical Contractor by the issue of all required technical details, wiring diagrams, wiring specifications (where possible), schedules of equipment, equipment locations, operating principles, and close liaison with this party at all times and in good time to meet the construction programme.

The Mechanical Sub-Contractor shall carry out the installation of all controls inter-wiring between all pertinent equipment he installs and its associated controls items, including containment and the wiring from the point of mains power (this point will be installed and any terminations made into it by the Electrical Contractor ie Others).
It is preferable that the Mechanical Sub-Contractor employs the project Electrical Contractor as HIS sub-contractor (and meets all associated costs for this directly within his tender price) to carry out the controls wiring installation on his behalf, in order to reduce possible issues through a third party involvement.

The Mechanical Sub-Contractor shall closely liaise with all other sub-trades and specialists (where applicable), and provide all relevant electrical wiring and connection details for mechanical equipment and controls etc, where appropriate, in good time.

3.19. WORK TO BE UNDERTAKEN

The Mechanical Sub-Contractor shall allow in his tender submission for the whole of the works described in this section including; the supply of all materials and fixings and labour & attendance necessary to complete the installation to the CAs satisfaction and as described on the drawings and in this document.

3.20. PRICING OF THE WORKS

The Mechanical Sub-Contractor shall compile the prices for the work on the tender summary included elsewhere in this document, and shall transfer the appropriate totals to the tender return sheet.
All elemental prices shall be completed in the Tender Summary.
Items filled in with "included", "zero" (or similar wording) may invalidate the tender.

3.21.0. STRIPPING OUT OF EXISTING

3.21.1. GENERAL

The Mechanical Sub-Contractor shall visit the existing site, and examine the installations to determine the full nature and extent and nature of the existing equipment which he is required to isolate, make-safe, drain & purge, remove and dispose-of within this project.

The following works specification clauses shall be read in conjunction with the tender drawings.
The main principles comprise the following key elements;-

- Isolate, safely drain/purge existing fluids
- Isolate & purge natural gas within local working area
- Protect all equipment and pipework etc that is to remain / be reused
- Temporary capping-off of heating, domestic water & drainage services as required
- Remove & make-good thermal insulation & cladding etc where appropriate
- Strip-back and modify HWS trace heating systems
- Disconnect and remove redundant pipework, line equipment & controls
- Remove all redundant equipment supports, brackets & attachment points
- Dispose of all redundant materials in accordance with good practice for separating site waste & recycling materials where practicable and of sufficient quantity.

In general, all existing services which require removal shall be isolated, made safe, drained, purged, stripped out.
All redundant equipment and plant shall be removed from site.
The Mechanical Sub-Contractor shall carefully coordinate and schedule his works to suit the planned main works sequence & overall programme.

Where any mechanical equipment has a mains electrical supply and/or controls cabling / connections, these shall be isolated and disconnected by an electrician or controls specialist employed directly by the Principle Contractor ie Builder.

It shall remain the responsibility of the Mechanical Sub-Contractor to carry out all applicable and necessary works fully to the satisfaction of the CA.

3.21.2. ISOLATION OF SERVICES & PHASING

It is a fundamental requirement for the Mechanical Sub-Contractor to make all due allowance for materials, and all necessary labour & attendance associated with isolation, purging & draining-down of existing services, in order to undertake the removals & strip-out works – and the reinstatement / new installations in such a manner that **disruption to the continuity of ALL EXISTING MECHANICAL SERVICES & LOCAL CONTROLS is reduced to an absolute practicable minimum.**
Where it is necessary to carry out additional temporary or permanent valve installations; carry out multiple inefficient short shut-downs; carry out works out of regular hours/times; to install any temporary assemblies; and to carry out multiple commissioning visits, in order to maintain the existing systems, then this shall be included by the Mechanical Sub-Contractor within his tender price.

NOTE!
The Mechanical Sub-Contractor shall not shut-down, isolate, or otherwise affect the normal operation of any existing service without the express specific written permission of the University's Maintenance Department.
The client will issue a permit to work for a specific service, location, date, time and duration – which shall be adhered-to without exception.
A notice period shall be given to the client when applying for such permits, which shall be not less than 7 (seven) calendar days unless expressly agreed otherwise by the client.
ALL NOTICE PERIODS SHALL BE ALLOWED AND SHOWN ON THE MECHANICAL SUB-CONTRACTOR'S PROGRAMME OF WORKS.

3.21.3. REMOVAL OF REDUNTANT PIPEWORK, HEATING, DUCTWORK, VENTILATION ETC

The Mechanical Sub-Contractor shall make safe, purge, de-pressurise, drain, dismantle and remove from site all redundant pipework, radiators (& casings), line equipment, ductwork, grilles, dampers, fans, controls, line equipment, brackets, thermal insulation, controls, sensors, heaters, batteries, coils, exchangers, refrigeration condenser units & associated pipework & insulation, etc. and all supports & brackets etc – as required to undertake the works shown on the tender drawings and described within this specification.

Any existing pipework branch tee fittings located on Domestic HWS and Tank/Mains-fed CWS made redundant due to the works, shall be cut-out and replaced with straight couplers, straight pipe sections and all thermal insulation (and labels/IDs) shall be made good to match existing finishes (including outer cladding & trace-heating where applicable).

Other dead-leg branches on a liquid or gas carrying pipework system shall also be removed where practicable – or where impractical – shall be isolated by means of physical break, and plugged/capped at source – and both ends of pipework shall be tagged and labelled accordingly as redundant, and where respective ends are located.

Ductwork branches may be removed in a similar fashion, with resultant redundant duct openings made good – in a fully aerodynamic manner, to avoid undue noise and static pressure generation.

3.22.0. INSTALLATION - HOT & COLD WATER PIPEWORK

3.22.1. GENERAL

The Mechanical Sub-Contractor shall adapt and extend the existing hot & cold water services (as applicable) to provide source of water supply for the Visitor WC as generally shown on the drawings.

The existing local water services which serve the existing domestic hot (F&R) and cold water outlets shall be connected to and extended to suit.

The existing pipework shall be adapted and extended via new valved pipework branches to serve the new outlets via as short a pipe route that is practicable.

The new hot water system shall be provided by installation of a new local electric semi-storage water heater, located in the adjacent store. New pipework serving the new outlets shall be routed via as short a pipe route that is practicable.

The Mechanical Sub-Contractor shall undertake pipework sizing and designs in accordance with relevant sections of current version BS EN 806.

The Mechanical Sub-Contractor shall include for all materials, supports and brackets, pressure testing, final refilling and venting and setting to work, including all new and making good existing thermal insulation, outer finishes and labelling (identification labels & direction arrows).

Circulation loops on HWS F&R system shall be adjusted and re-balanced to suit the altered system.

Tap outlets and cistern fill valves will be provided along with the sanitaryware by the Building Contractor ie others.

3.22.2. PIPEWORK – WITHIN BUILDINGS

The Mechanical Sub-Contractor shall allow in the tender for the supply and installation of the new insulated Hot & Cold Water Services systems as described in this specification and as suggested on the drawings.
The Hot & Cold Water installation shall be carried out in table-X copper tube to BSEN1057 with lead-free soft-soldered copper solder-ring fittings exclusively of Yorkshire (PeglerYorkshire Ltd) manufacture.
Pipework on-view shall remain plain un-insulated, and be of high quality-chrome-plated copper, with matching brackets and fittings.

Compression type pipe fittings in the distribution system <u>are forbidden</u>, with the exception of connections to line equipment (ie line valves, strainers, regulating valves) and final connections to equipment – where practically unavoidable for maintenance reasons.

The pipework shall be installed in the sizes, and shall follow the routes as determined by the Mechanical Sub-Contractor's agreed design. All installations shall be carried out in accordance with the Standard Specification.

3.22.3. CONNECTIONS

The new installation shall serve the new distribution systems & outlets by the making of new connections to/from new plant and equipment / pipework systems, as generally shown on the drawings.
The Mechanical Sub-Contractor shall carefully plan and organise in good time, the making of any connection to existing systems which may result in the isolation of existing services and / or systems.
The likely duration of any interruption of normal service shall be discussed and planned with the CA and Client well in advance, to ensure preparations are be carefully made.

The Mechanical Sub-Contractor shall minimise the disruption to existing services during any break-in / connection work required to a demonstrable absolute practical minimum through the pre-manufacture and installation of assemblies, valves and pipe sections.
The Mechanical Sub-Contractor shall make final connections to all new and existing appliances, equipment and items of plant, as determined by the Mechanical Sub-Contractor's agreed design.

<u>It is anticipated that there are unlikely to be convenient isolation and drain-off points located near to the new points of connection into existing pipework.</u>
<u>Furthermore, it is anticipated that any existing valves could unreliable in operation and hence not be depended upon for full water shut-off.</u>
<u>In all cases (ie every new connection or work on existing system connections), the Mechanical Sub-Contractor</u>

shall undertake cryogenic (freezing) of up and downstream pipework in order to shut-off the flow of water and allow installation of new valves and pipework.

3.22.4. VALVES & LINE EQUIPMENT

Valves & Line Equipment shall be fitted into pipework lines, generally as following general styles:

System	Location	Type
Main Distribution	Main Branches, Sub-Branches and Key Points of Source	¼-Turn Lever Handle
Equipment Isolation	Supply Pipework In / Service Pipework Out	¼-Turn Lever Handle
Final Outlet Isolation	Final Pipework Local to Outlet	¼-Turn Service (colour coded)

Equipment shall generally be of nominal size to match the pipework into which they are fitted unless otherwise stated, and be of the types as specified below;-

Mfr: Crane Ltd

Service	CWS / HWS
Function	Branch Isolation
Type	¼–Turn Lever Handle
Diameter <65mm	D171c

All equipment shall be WRAS approved.

Mfr: Pegler Yorkshire Ltd

Service	CWS / HWS
Function	Final Outlet Isolation
Type	¼–Turn Service
Diameter 15/22mm	PB300T (red/blue handles)

All equipment shall be WRAS approved.

All line equipment shall be located with due regard for the effective fitting of thermal insulation (where applicable) to adjoining pipework, fittings, plant, and any thermal wrap covers – all of which shall not inhibit the regular function or operation of each item.

3.22.5. THERMAL INSULATION – HWS/CWS

Thermal insulation of any part of the installation shall not be commenced until all pressure testing for the whole installation (or agreed phase/section thereof) is successfully completed and witnessed/signed-off.
The entire new HWS and CWS pipework system shall be comprehensively insulated with pre-formed mineral-wool sections, with aluminium foil finish, fixed and jointed with matching self-adhesive aluminium foil tape, all in accordance with BS 5422:2009, and the Standard Specification.
CWS pipework insulation thickness shall be determined based on fluid temperature of 10 deg.C for condensation control and limiting heat gains from surroundings, into pipework contents.
HWS pipework insulation thickness shall be determined based on fluid temperature of 60 deg.C for limiting heat losses from pipework contents, to surroundings.
All insulation ends shall be fitted with aluminium capping prior to fitting valve and flange covers, etc.

Details of final outer finishes required:

Area/Location	Service	Finish
Internal Building / Generally (where hidden from general view)	HWS / CWS	Insulation basic foil finish with matching foil tape joints, and aluminium end-capping
Internal Building / Occupied Rooms (where pipework mounted generally on-view above 2.0m AFFL)	HWS / CWS	'Isogenopac' Light Grey outer finish (in addition to the basic foil finish) with PVC rivetted fasteners, matching tape joints, and aluminium end-capping

The complete installation shall be carried out in accordance with the Standard Specification and all materials shall be entirely compatible with the pipework to which it is fitted.
Line equipment and valves within plantrooms, ducts, risers, voids, and mounted external to the building envelope- shall be fitted with a custom-made wrap-around removable insulation covers (attached with velcro fixings, and Securing Cord) as manufactured by Fosse Insulation Ltd - tel: 0116 255 9005, or similar approved.)

Equipment that SHALL be fitted with insulation covers:-
Valves, Strainers, Commissioning/flow Measuring Equipment, Flanges, Flexible Connections, Expansion Bellows, Unions, Control Valves, Pumps.

Equipment NOT to be insulated:-
Pressure safety valves, Small bore drain valves, Test Points, Small bore air vents, Chemical dosing pots, Gauge cocks & tails, Pressure switch/sensor cocks & tails, Expansion vessels.

3.22.6. SYSTEM FLUSHING

The Mechanical Sub-Contractor shall undertake flushing of the newly installed Hot & Cold Water Services installation using clean mains water in accordance with BS7592 (2006), and shall clean out any line strainers thereafter – all prior to making final connections and filling of the system.

3.22.7. OUTLET LABELS

The Mechanical Sub-Contractor shall affix self-adhesive vinyl printed labels adjacent to the following outlets:

Type	Label Text
Drinking Water (Wholesome)	"Drinking Water"
Tank Water	"Not Drinking Water"
Hot Water (unblended)	"Danger Very Hot Water"

3.22.8. TESTING & COMMISSIONING

The Mechanical Sub-Contractor shall carry out successful pressure testing to the entire new installation (where practicable), in accordance with the standard specification. This shall be carried out in sections to suit the phased completion of the works in each location, where applicable.
All pipework and equipment shall be drained-down after any hydraulic pressure testing, until sterilisation is required.
Test certificates shall be provided for each system and sub-section thereof being tested.

All pipelines shall be tested in accordance to Standard Specification.

Where appropriate, the Mechanical Sub-Contractor shall carry out partial testing of the installations, in order to ensure that pipe lines are successfully tested for leakage prior to being insulated and covered-over.

The Mechanical Contractor shall not pressure test any element of existing pipework but shall limit testing to the new installation only, in accordance with the Standard Specification.

Shortly prior to putting into use, the entire new pipework systems shall be flushed with clean water, and then sterilised in accordance with the Standard Specification.
It is expected that the sterilising solution will be drawn finally through outlets in the buildings which the pipework serves, and hence this work shall be undertaken out of normal hours, when the buildings will be unoccupied.

Water samples from the newly connected hot & cold water outlets shall be carefully taken.
Each water sample shall be collected, handled, stored, analysed, tested and reported in accordance with the procedures, guidance and requirements set out in the Standard Specification.

Where the outlets, appliances, whole area or building being served by the new / modified-existing water supply will not be put into immediate regular usage, the Mechanical Sub-Contractor shall maintain the newly sterilised systems by carrying out regular flushing on a daily basis and recorded on a flushing record sheet.

All flushing record sheets shall be collected and inserted into the O&M / Record information for the project.

All testing and commissioning shall be carried out in accordance with the Standard Specification.

3.23.0. INSTALLATION OF – LTHW & ELECTRIC HEATING SYSTEMS

3.23.1. GENERAL

The Mechanical Sub-Contractor shall adapt and extend the existing LTHW Heating System to provide source of heating supply for the existing/relocated, and new Heating Radiators as suggested on the drawings and/or those proposed by the Mechanical Sub-Contractor within his design proposal.

The existing local LTHW Heating Services which serve the existing radiators shall be connected-to, and extended to suit, in a manner that can be demonstrated to align with good design practice and expected system performance criteria.

The existing pipework shall be adapted and extended via new valved pipework branches to serve new or relocated existing radiators.

In all instances, references to existing radiators / new radiators that are LST type shall be considered to include any protective casing.

The Mechanical Sub-Contractor shall undertake pipework & equipment sizing and designs in accordance with relevant sections of the applicable CIBSE Guides.

The Mechanical Sub-Contractor shall include for all materials, supports and brackets, pressure testing, final refilling and venting and setting to work, including all new and making good existing thermal insulation, outer finishes and labelling (identification labels & direction arrows).

In other (Circulation Link Corridor) areas, space heating shall be achieved by the installation of Ceiling-Mounted Electric Radiant Heating Panels (including associated sensors, thermostats, switching contactors and smart control hub unit(s)) and as identified within the Room Data Sheets, and indicated on the tender drawings.

The entire installation shall be carried out in accordance with the requirements of the Standard Specification and the IET Wiring Regulations (BS7671).

3.23.2. LTHW HEATING PIPEWORK

The Mechanical Sub-Contractor shall allow in the tender for the supply and installation of the new insulated LTHW Heating system distribution as described in this specification and on the drawings.
The Hot & Cold Water installation shall be carried out in HEAVY GRADE mild steel tube to BS EN10255 with screwed joints up to 50mm diameter, and welded 65mm dia. and larger.
New isolation valves shall be added where none exist, in order to rapidly restore service to a drained-off or isolated system during stripping-out works.
Any isolation required on systems where no existing local isolation valves exist, shall be undertaken by cryogenic freeze, all within the tender offer.

In areas where the pipework installation is predominantly of another method ie crimp-fit 'Mapress' – the entire new local installation shall be undertaken in the same materials (including manufacturer) and jointing system to match the existing.

Compression type pipe fittings in the distribution system are forbidden, with the exception of connections to line equipment (ie line valves, strainers, regulating valves) and final connections to equipment – where practically unavoidable for maintenance reasons.

The pipework shall be installed in the sizes, and shall follow the routes as determined by the Mechanical Sub-Contractor's agreed design. All installations shall be carried out in accordance with the Standard Specification.

3.23.3. LTHW PANEL / LST RADIATORS

The Mechanical Sub-Contractor shall supply and install radiators generally on outside-facing walls and under windows where practicable, as determined by the Mechanical Sub-Contractor's agreed design.

Radiator valve connections shall be made at bottom-bottom-opposite-ends where practicable.

The radiator flow connection shall be equipped with a thermostatic radiator valve, and the return shall be equipped with a lock-shield radiator valve.

On Panel Radiators connected to conventional 2-pipe heating systems, the radiator valves shall be as follows:-

Manf. - Danfoss Commercial UK Ltd

Horizontal Radiator	**Type**
TRV Body	RA-FN 15mm Horizontal Angle
TRV Head	RA2920
Return Lock-Shield	RLV-S 15mm Angle

For radiators with low-surface temperature casings, the TRV shall be equipped with a remote-adjustable setting/sensing head, mounted to the side of the LST casing & connected via capillary link.

On single-pipe systems, the radiator valves shall be of same manufacturer/range as per above, however be eminently suited and design for a single-pipe heating system (ie ultra-low pressure loss).

The Mechanical Sub-Contractor shall disconnect, remove, and re-hang each radiator (and any LST casing) once after initial installation for the purpose of allowing decoration of the wall finish as necessary.

Unless otherwise stated, all 'standard' Radiators shall be as manufactured by Myson Ltd, and be from their "Décor" range (Horizontal Type), factory finished in white RAL 9010 colour, and complete with suitable brackets etc. and shall generally be at least 500mm high (unless unavoidable, to fit below low-height window sill level) – and selected so as to be as slim as practicable given the wall space available and thermal output required. All final radiator sizes (& colours) shall be agreed with the CA prior to ordering.

The 'Low Surface Temperature' Radiators shall be as manufactured by Myson Ltd, and be from their "LST" range, factory finished in white RAL 9010 colour, and complete with suitable brackets etc. and shall generally be at least 600mm high overall (unless unavoidable, to fit below low-height window sill level) – and selected so as to be as slim as practicable given the wall space available and thermal output required. All final radiator sizes (& colours) shall be agreed with the CA prior to ordering.

As an exception to the above – with the Junior School areas, where the radiator types are predominantly of a standard panel convector radiator type, the equipment shall be selected to match that particular style (including manufacturer) to match those existing. <u>This is expected to apply to the new Office and Entrance Lobby only.</u>

Radiators shall be designed to achieve the room temperatures as listed within this specification at an external design temperature of -5deg.C.
All radiators and other heat emitters shall be sized including a factor for intermittency equivalent to at least 25% of the steady-state heat loss for the room.
The equipment shall be selected to provide its maximum designed output at system temperatures of 80deg.C flow, and 70deg.C return and room temperature / ventilation rate as per Room Data Sheets.

The installation shall be carried out in accordance with the Standard Specification.

3.23.4. CONSTANT TEMPERATURE LTHW SUPPLY FOR OVER DOOR AIR CURTAIN

The Mechanical Sub-Contractor shall supply and install a complete new independently pumped CT LTHW Flow and Return circuit, dedicated to the new Over-Door Air Curtain heater as included elsewhere within this project.

The new circuit shall be connected to (and served from) the existing gas-fired boiler heating system within the Boiler Plantroom as located and indicated on the drawings.

The Mechanical Sub-Contractor shall design and install a new circuit connected from the load-side of the existing CT LTHW heating system primary boiler circuit, which shall circulate system water through a new 'Low Loss Shunt Header', and then on to the new outgoing F&R CT LTHW circuit via a new single-head canned-rotor pump, capable of handling the flow rate and resistance of the new pipework and heater matrix.
The new CT LTHW heating pump shall be as Manufactured by Grundfos Ltd and be of the Magna range with variable speed setting – connected via local resilient pipework flexes, and having altitude gauges either side – and supported via dedicated bracketry.

The Mechanical Sub-Contractor shall supply and install the mains electrical power supply to the pump via local electrical isolator, which shall be derived from the local heating control panel, and install a pipework thermostat and dedicated timeswitch control to energise the pump when the boilers and firing and during scheduled times required.

The entire installation shall be carried out in accordance with the requirements of the Standard Specification and the IET Wiring Regulations (BS7671).

The new pipework circuit shall feature isolating and regulating valves, and measuring stations as required to facilitate system balancing and commissioning.
The new pipework shall be filled with clean fresh water after completion of pressure testing, and have sufficient corrosion inhibitor treatment to match the chemical type and concentration within the existing heating system (all to be determined by the Mechanical Sub-Contractor).

3.23.5. THERMAL INSULATION (LTHW HEATING)

Thermal insulation of any part of the installation shall not be commenced until all pressure testing for the whole installation (or agreed phase/section thereof) is successfully completed and witnessed/signed-off.
Where heating system pipework is installed within plantrooms, equipment cupboards, voids, boxings, risers, ducts, and any other areas not generally occupied (unless specifically mentioned otherwise), and in occupied rooms where routed on-view above door height (ie High Level), then it shall be insulated with **pre-formed mineral wool sections, with aluminium foil finish**, fixed and jointed with matching self-adhesive aluminium foil tape, all in accordance with the Standard Specification.
All insulation ends shall be fitted with aluminium capping prior to fitting valve and flange covers, etc.

Details of final outer finishes required:

Area/Location	Service	Finish
Internal Building / Generally	LTHW Heating	Insulation basic foil finish with matching foil tape joints, and aluminium end-capping.
Internal Building / Occupied Rooms	LTHW Heating	Insulation basic foil finish with matching foil tape joints, and aluminium end-capping. Outer-covering of ISOGENOPAK light grey plastic finish with matching fixings. (ONLY WHERE BENEFICIAL HEAT NOT REQUIRED/SPECIFIED)

The complete installation shall be carried out in accordance with the Standard Specification and all materials shall be entirely compatible with the pipework to which it is fitted.

Pipe identification bands shall be fitted to the outer finish of the pipework insulation, coded and annotated in accordance with the Standard Specification.

All line equipment and valves (in all locations where pipework insulation is to be applied) shall be fitted with a custom-made wrap-around removable insulation covers (attached with velcro fixings, and Securing Cord) as manufactured by Fosse Insulation Ltd - tel: 0116 255 9005, or similar approved.)

Equipment that SHALL be fitted with insulation covers:-
Valves, Strainers, Commissioning/flow Measuring Equipment, Flanges, Flexible Connections, Expansion Bellows, Unions, Control Valves, Pumps.

Equipment NOT to be insulated:-
Pressure safety valves, Small bore drain valves, Test Points, Small bore air vents, Chemical dosing pots, Gauge cocks & tails, Pressure switch/sensor cocks & tails, Expansion vessels.

3.23.6. ELECTRIC RADIANT PANEL HEATERS

The Mechanical Sub-Contractor shall supply and install new mains powered, electric panel heaters in the location as determined by the Mechanical Sub-Contractor's agreed design.

The panel heaters shall be installed using manufacturer's supplied brackets, with suitable fixings, and with good access for operation and maintenance (in accordance with manufacturer's requirements), and shall be tested, commissioned and set to work.
The Mechanical Sub-Contractor shall be fully responsible for undertaking the mains power wiring installation from a local source of primary power supply (provided by others), through the control contactor, and to serve each heating panel within each respective room/zone.
Primary power supplies for contactors (smart relays), thermostats, smart hum controllers shall be provided and finally connected by others.

The Mechanical Sub-Contractor shall be responsible for the supply, installation, testing, commissioning and demonstration of the Electric Radiant Panel Heating systems, all local and central controls.
Final electrical power connections to radiant panels shall be via plug/socket similar to lighting plug-in system, for ease of maintenance and replacement.

Electric radiant panel heaters shall have local thermostat controls, time scheduled operation via the central smart-hub, open window sensing, be Lot-20 compliant (according to EU EcoDesign legislation) – and be manufactured by Yandiya Ltd, and factory finished in white RAL 9010 colour.
The electric radiant heating equipment and associated controls shall be checked and commissioned by the manufacturer or his agent in order to acquire their extended product warranties.
Yandiya Contact Details as below:-

Jason Roath
Business Development Director

YANDIYA Technologies Ltd

m: +44 (0)7778 404040
t : +44 (0)1329 556575
e : jason@yandiyatechnologies.com
i : info@yandiyatechnologies.com
w : www.yandiyatechnologies.com

4 Brunel Way, Segensworth, Fareham, PO15 5TX

Electric Radiant Panel Heaters shall be designed to achieve the room temperatures as listed within this specification at an external design temperature of -5deg.C.
Electric Radiant Panel Heaters shall be sized including a factor for intermittency equivalent to at least 25% of the steady-state heat loss for the room.

All controls shall be from the SALUS Controls Range, as recommended and available via YANDIYA, along with the

Electric Radiant Panels.

Smart Pack - 2 Zone

YTL-SP-2

PRODUCT DESCRIPTION

Includes:
1 x UG600 Universal Gateway
2 x SR600 Smart Relay 16Amps
2 x HTRP-RF(50) Thermostat

WINDOW SENSOR FOR SMART HOME

OS600

PRODUCT DESCRIPTION

The OS600 window sensor is a small, wireless piece of equipment that detects when a window is open or closed and reports this to the SALUS iT600 Smart Home App.This product must be used with the SALUSSmart Home gateway.

All controls requiring batteries shall be supplied with industrial quality cells, and a full spare set for all equipment also handed over to the client at completion.
The controls shall be programmed and set up by the Mechanical Sub-Contractor, to suit the occupancy times as required by the end users, and shall demonstrate the use of the controls and settings to them.
The installation shall be carried out in accordance with the manufacturer's requirements, and generally in accordance with the suggested locations as shown on the tender drawings.

The entire installation shall be carried out in accordance with the requirements of the Standard Specification and the IET Wiring Regulations (BS7671).

3.23.7. OVER-DOOR AIR CURTAIN HEATERS

The Mechanical Sub-Contractor shall supply and install new LTHW-heated (suitable for 82/71C F&R System Temps), over-door air-curtain heater unit in the location as generally suggested on the tender drawings.

The door screen heaters shall be installed using manufacturer's supplied brackets, with suitable fixings, and with good access for operation and maintenance (in accordance with manufacturer's requirements), and shall be tested, commissioned and set to work.

The supplied unit controller shall have integral / local digital 7-day, 24-hour time controller with back-lit LCD display, digital temperature control including setback programme, lock-out facility for controls, summer/winter and fan-speed controls, automatic mode for all settings, manual on/off/auto modes,

The door screen heaters shall be sized to cover the full door width opening, and be sited to suit the door frame and any door automation controls, etc.
The door screen heaters shall be flush-mounted type as preference where there is a demountable suspended ceiling, or surface suspended type otherwise – and be complete with safety temperature cut-out, temperature sensing, remote user controls, return air filter, and be selected to be comparatively quiet operation for equipment of this type and nature.
The door screen heaters shall all be as manufactured by Thermoscreens Ltd or Envirotec Ltd, and factory finished in white RAL 9010 colour.

Under no circumstances shall an electrically-heated Over-Door Air Curtain heater be substituted for the specified LTHW-heated unit required.

The door screen heaters shall be designed to achieve the room temperatures as listed within this specification at an external design temperature of -5deg.C.

The controller shall be programmed and set up by the Mechanical Sub-Contractor, to suit the occupancy times as required by the end users, and shall demonstrate the use of the controls and settings to them.

The installation shall be carried out in accordance with the manufacturer's requirements, and generally in accordance with the suggested locations as shown on the tender drawings.

All electrical wiring and supplies, all final connections etc will be installed, connected and tested by the Electrical Contractor ie Others.

3.23.8. TESTING & COMMISSIONING

The Mechanical Sub-Contractor shall carry out successful flushing-out and pressure testing to the entire new installations in accordance with the standard specification, prior to final opening-up to the existing system & final filling-up.
All pipework and equipment shall be drained-down after any hydraulic pressure testing.
Test certificates shall be provided for each system and sub-section thereof being tested.
Allowance shall be made for sufficient air venting of all new and existing local circuits affected by the alteration, modification and installation works on the local heating zone – all prior to final flow rate commissioning.

<u>The Mechanical Sub- shall utilise a skilled, qualified and experienced specialist to undertake the commissioning works.</u>

The Mechanical Sub-Contractor shall test and commission the complete new installation in accordance with the Standard Specification.
The Mechanical Sub-Contractor shall clean-out all line strainers - where appropriate, immediately before any final commissioning procedures are carried out.
The Mechanical Sub-Contractor shall set up the new LTHW system to meet the required design flow rates as demanded by the new equipment installed.
Furthermore, the Mechanical Sub-Contractor shall determine the baseline existing system flow rates, and carry out a system re-balance to restore these figures after adding any new circuits.

Allowance shall be made for a seasonal re-commission visit at the commencement of the site's heating season – at which time the new and existing local heating system zone circuit emitters shall be checked and thermally balanced to achieve suitable temperature drop based on room and compensated heating circuit temperatures on the day.

All test result figures shall be presented to the CA as soon as they are available.
All testing and commissioning shall be carried out in accordance with the Standard Specification.

3.24.0. INSTALLATION OF – ABOVE GROUND DRAINAGE

3.24.1. GENERAL

The Mechanical Sub-Contractor shall remove redundant existing, adapt & modify remaining, and supply & install complete above ground drainage installations as described in this specification and as suggested on the tender drawings.
The new above-ground drainage systems (AGD) installations shall connect the new sanitaryware, and other specified equipment installations, to new / existing above-ground drainage systems, and generally comprises:-

* Combined Soil & Vent Waste Drainage Systems – Above Ground

Pipework shall be installed in grey or white thermoplastic PVC tube and fittings with adaption to suit existing soil/drain stack connections as required.
The Mechanical Sub-Contractor shall carry out the works without undue disruption to the services to the rest of the building - and shall carry out any disruptive break-ins / isolations out of normal hours.
Due care shall be taken by operatives working on the foul systems within the building, and shall treat all drainage systems as containing hazardous contaminants which shall be dealt with accordingly within the risk assessments.
The Mechanical Sub-Contractor shall undertake pipework sizing and designs in accordance with relevant sections of current version of BS EN 12056.

3.24.2. DRAINAGE & SOIL PIPEWORK

The Combined soil & vent above ground drainage system shall be installed to comply with the current Building Regulations Part H1 – "Drainage and Waste Disposal – Foul Water Drainage", and shall generally comprise;-
A suspended soil system type: "Osmasoil" as manufactured by messrs. Wavin Ltd, with solvent-welded joints, shall be installed in full compliance with BS5955: Part6:1980 "Code of Practice for Plastic pipework" (Installation of unplasticised PVC pipework for Gravity Drains & Sewers) & BS8301:1985 "Code of Practice for Building Drainage" & BS-EN 12056 "Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation" and in strict accordance with the manufacturer's instructions.
The suspended drainage system shall generally be installed to falls of 1 in 40 on suspended bracketing system at centres of no more than 1000mm, or at falls to suit self-cleaning velocities.
Bends shall be of the larger radius, swept type.
Branches and manifolds shall be sized and graded to suit, and shall be in accordance with the regulations.
Where required and not shown, air admittance valves shall be provided to avoid induced siphonage.
Rodding access shall be provided at strategic points throughout the installation.
Where appropriate, venting to soil stacks shall terminate at least 1000mm above the highest point of any adjacent building opening (windows etc).
Sanitaryware shall be fitted with applicable trapping as required. Where pipework passes through fire barriers, a "Quelfire Collar" or similar shall be utilised to maintain the fire integrity of the fire compartmentation.

3.24.3. TRAPS

These will be provided and installed to sanitaryware by the Mechanical Sub-Contractor.
As a default all P-traps shall be deep-seal 'bottle' style, with integral air-admittance valve.
Any other running line traps shall be proprietary 'wet' traps or where applicable shall be 'waterless' dry traps – as shown/described.

3.24.4. TESTING

The Mechanical Sub-Contractor shall test and set to work, the new AGD system in accordance with all applicable BS/EN codes of practice and the current Building Regulations.

3.25.0. INSTALLATION - MECHANICAL VENTILATION

3.25.1. GENERAL

The Mechanical Sub-Contractor shall undertake the works as generally described in the specification, Room data sheets and as suggested on the Tender Drawings.

Redundant wall extract fan(s) shall be removed.

The newly reformed Visitor's WC and the other existing adjacent WC shall be equipped with wall mounted extract fans to provide extract ventilation due to lack of external opening windows, to meet the performance requirements as per the Room Data Sheets, and other design requirements.
The fan exhaust shall be ducted to the nearest outside location via PVC ducting supported throughout the route.

The new Admin Office shall be fitted with a MVHR-based supply and extract mechanical ventilation system, in order the to meet the performance requirements as per the Room Data Sheets, and other design requirements.

The Mechanical Sub-Contractor shall undertake ductwork & equipment sizing and designs in accordance with relevant sections of the applicable CIBSE Guides.

The Mechanical Sub-Contractor shall include for all materials, supports and brackets, pressure testing, final setting to work, including all new and making good existing thermal insulation, outer finishes and labelling (identification labels & direction arrows).

Where equipment is located externally to the building, it shall be inherently fully weather proof or further weather proofed to suit the location and exposure.

3.25.2. NEW DUCTWORK

The new extract ventilation systems shall be installed in a proprietary solid spiral-wound galvanised mild steel duct system with gasketted branch & tee fittings, line VCD dampers, fire dampers, (messrs. Lindab or similar/approved quality), regular supports, fixings at joints, and intumescent collars at the fire compartment demarcation lines -along with thermal insulation to all supply-air ductwork, and fresh-air intake ductwork from external termination, up the MVHR unit.

As part of the work to be done, it is mandatory for the Mechanical Sub-Contractor to prepare and submit fully detailed, coordinated and dimensioned 'shop' fabrication drawings suitable for the manufacturing of the supply and extract ductwork systems, to the CA no later than two working weeks before they are required.

The coordination of the plant, ductwork, grilles etc. with the new & existing services, the building fabric and structural elements shall be executed to the very highest standards.
No work shall proceed until all detrimental comments have been resolved.
Failure to resolve these details in a timely manner to acceptable levels of detail will result in a delay to the contract, solely at the Contractor's expense.

The installation shall be undertaken in accordance with the Standard Specification for materials and workmanship.

3.25.3. MECHANICAL VENTILATION HEAT RECOVERY UNITS (MVHR)

The Mechanical Sub-Contractor shall design, select, supply and install ducted heat recovery type supply and extract air handling units in the locations as generally shown on the drawings, or as determined by his design proposal.
All locations shall be subject to final site coordination with other services, structure, building elements and new ceilings & finishes etc.
Each MVHR unit shall feature integral air intake filters (at least M5 performance), air extract filters (where required), recuperator type heat recovery unit with bypass damper system, integral (or external) electric 'top-up' heater battery (thyristor driven), integral supply and extract fans, integrated control, and remote user control facility (including 24 hour / 7 day time programme schedule).
The MVHR shall be suspension mounted from soffite using suitable fixings, and drop-rod arrangement to

adequately bear the load of the unit – all in accordance with the manufacturer's requirements.
Alternatively, the units shall be externally rooftop mounted, and be inherently weatherproof.
The MVHR installation shall include insulated circular air intake/exhaust ducts (including all necessary offsets, supports, bends etc) supplied by the Mechanical Sub-Contractor.
Air intake and exhaust ducts shall include rid mesh screens, and be angled & shaped to face away fgrom prevailing wind and rain.
The mechanical sub-contractor shall mount the unit, install final mains power connection from primary mains power supply point (to be installed & terminated by others) and install all necessary mains final and control wiring, containment routes, terminate and fully test.

Any externally-mounted plant and ductwork shall be supported on 'Roofpro' or 'Bigfoot' type supports with GMS H-frame 'goalpost' brackets, and any sacrificial roof protection measures required.

The room-side and atmosphere-side ductwork connections from the MVHR unit shall feature ducted in-line attenuators designed and selected to achieve the specified internal and any external noise level limits.

The MVHR unit shall have its condensate drain connection piped to a local drainage system (via waterless trap) via solvent-welded PVC pipework, laid to fall above ceilings, and supported adequately throughout.

All primary mains power supplies will be installed by others to a local point of isolation.

The MVHR units shall be as manufactured by Daikin Europe Ltd – type 'VAM' series, or Mitsubishi Electric Ltd – type 'Lossnay' – and shall be selected and their mid range performance speed to meet the Mechanical Sub-Contractor's design criteria (airflow performance).

3.25.4. LOCAL WALL EXTRACT FANS

The Mechanical Sub-Contractor shall design and select the new extract ventilation fan units to be installed within the Visitors and adjacent existing WC.

The extract fans shall meet the design requirements listed in the Room Data Sheets , and other design requirements.

The fans shall be set up by the Mechanical Sub-Contractor, to suit the run-on time required.
The installation shall be carried out in accordance with the manufacturer's requirements, and generally in accordance with the suggested locations as shown on the tender drawings.

The new extract fan exhaust air ducts shall be equipped with a colour-coded PVC grille with integral cowling & backdraught shutter, to match the surrounding wall finish colour.

All electrical wiring and supplies, all final terminations etc will be installed, connected and tested by the Electrical Contractor ie Others.

The extract fan unit shall be a centrifugal type unit, with integral controls, PIR sensor, back-draught shutter, from the 'Lo Carbon' range, to meet the required performance at mid or low speeds (where applicable) - and be as manufactured by Vent Axia Ltd, or similar quality - approved.

3.25.5. FIRE DAMPERS

The Mechanical Sub-Contractor shall install fusible-link mechanical curtain Fire Dampers into the new ductwork systems in the various locations as generally shown on the drawings.
The FDs shall each be complete from the factory with installation hardware suitable for the building construction into which they are fitted.
The Fire Dampers shall have an installed fire integrity of at least 60 minutes.
Ductwork immediately up and downstream of each fire damper shall be fitted with an insulated duct access door for maintenance, inspection and resetting of the damper mechanism.
All Fire Dampers shall be successfully drop-tested upon completion of the ductwork installations.
One set of spare fusible links shall be provided for all installed dampers.

3.25.6. VOLUME CONTROL DAMPERS

The Mechanical Sub-Contractor shall design, select and install multiple opposed-blade volume control dampers into the new ductwork systems, in locations to suit optimal safe access, to reduce impact of regenerative noise into the room, to facilitate optimal effective balancing of the primary distribution legs and secondary sub-sections of the ductwork systems.
Terminal regulation shall not be used as means to balance any main or sub-branch system.
All dampers shall be complete with easy operating handles, a clear indication of damper operating position, and a simple means of locking.
All dampers shall be clearly marked with their final commissioned position.

3.25.7. VENTILATION TERMINAL VALVES

The Mechanical Sub-Contractor shall design select, supply and install new ventilation terminal valves in the locations as required by his design proposal.
These units shall be fitted where new MVHR system outets and inlets are required within a room (noted on drawings as Supply and Extract 'grilles'.
The ventilation terminals shall be as manufactured by Gilberts (Blackpool) Ltd – Type "SX" and "GX" – sized and selected according to the manufacturer's product guidance.

Final air system balance shall not be carried out by throttling of the terminal valves.

3.25.8. THERMAL INSULATION

Thermal insulation shall be fitted to all new supply (including fresh air intake) ductwork throughout this project.
The insulation shall be mineral wool material with silver aluminium foil finish.
Outer finish of all insulation shall be finally fitted with identification labels and airflow direction arrows.
The materials and installation shall be in accordance with the standard specification.

3.25.9. TESTING & COMMISSIONING - VENTILATION

The Mechanical Sub-Contractor shall employ a specialist ventilation commissioning company to carry out all of the airflow rate testing and recommissioning.
in accordance with the Standard Specification.
The Mechanical Sub-Contractor shall set up the new ventilation system to meet the required design flow rates as demanded by the new equipment installed, in close liaison with the Engineer.
All test result figures shall be presented to the CA as soon as they are available.

All new and existing plant and controls shall be put into operation.

3.26.0. DX REFRIGERATION COMFORT COOLING SYSTEMS

3.26.1. GENERAL

The following works specification clauses shall be read in conjunction with the room data sheets, and the tender drawings.
The main principles comprise the following key elements;-

- Install new refrigeration comfort-cooling plant
- Install new insulated refrigeration pipework and condensate drainage
- Install new system controls and power/controls inter-wiring

The Mechanical Sub-Contractor shall fully design, select and install the new comfort cooling systems within this project.
A specialist refrigeration sub-contractor with recognised credentials in the refrigeration industry shall be engaged by him. Only skilled and qualified tradesmen shall be utilised to carry out this element of the works.
The whole installation shall be carried out in accordance with DEFRA guidelines / requirements and F-Gas regulations, and the IET Wiring Regulations (BS7671).

Heat Pump Systems shall be designed to achieve the room temperatures as listed within this specification at an external design temperature of -5deg.C.
The cooling performance of the system will be secondary and no particular performance criteria are required, provided the winter heating performance of the system exceeds the calculated minimum requirement.
Heat Pump Systems shall be sized including a factor for intermittency equivalent to at least 25% of the steady-state heat loss for the room.

The plant and equipment shall be as manufactured by Daikin Europe Ltd.
The refrigerant shall be R32.

The controller shall be programmed and set up by the Mechanical Sub-Contractor, to suit the occupancy times as required by the end users, and shall demonstrate the use of the controls and settings to them.
The installation shall be carried out in accordance with the manufacturer's requirements, and generally in accordance with the suggested locations as shown on the tender drawings.

3.26.2. NEW REFRIGERATION PIPEWORK & INTER-WIRING

All refrigeration pipework, supports, pipe and cable tray, interconnecting electrical power and controls wiring, surface trunking, condense drains, condenser unit brackets, heat pump drain trays & drains (as applicable), and internal unit condense pumps, user controls and all associated testing, commissioning and setting to work shall be included within this project.

The internal room units shall be connected using the manufacturer's recommended pipework arrangement in a "Single 1:1 Split" type arrangement, utilising a single external condenser unit connected an outdoor unit respectively.

The pipework installation shall comprise the routing of degreased malleable copper tubing in the sizes as recommended by the manufacturer's selection guides, from the indoor room cassette units.
Within voids, boxings, ceilings, service risers – the pipework shall be routed along suspended galvanised steel (GMS) tray work, hung from the immediate soffite / cantilevered / flat to wall on stand-off channels, and/or using threaded-rod & channel hanger supports.
All apertures or penetrations between internal and external shall be neatly made, and sealed using closed-cell expanding foam – trimmed flush to the surrounding finishes.
All fire compartment penetrations shall be suitably protected using fire collars and intumescent fire rated sealants, etc.
Surface-mounted trunking (where fitted) shall be as manufactured by Inoac Ltd, Heronhill Ltd, or Aspen Ltd, and be complete with matching bends, end caps, tees and all other fittings.

All pipework shall be thermally insulated using closed-cell material in continuous lengths with minimal (glued) joints, type: Armaflex as manufactured by Armstrong Industries, or similar approved – installed in accords with

the manufacturer's recommendations.
The insulation routed externally shall be painted with UV-protection coating.
The insulated pipework shall be attached to the GMS tray-work using stainless-steel tie-wrap fixings (plastic tie wraps are not permitted).

The internal room units shall receive a power supply either direct from the local power source, or derived from the external condenser unit, as required/recommended by the equipment manufacturer's installation manual.
The primary power supplies to each system shall be derived from individual mains electrical supplies provided to terminate into the condenser unit ~~(or room unit as applicable)~~ via a local isolator, by others.
The isolators throughout the installation shall be labelled as to the source of their power supply (using agreed references and circuit way numbers as applicable).
Each indoor room unit shall be fitted with a local electrical isolator in the form of a double-pole isolator or fused-spur unit.
Interconnecting mains power cabling between indoor and outdoor units shall be installed by the Mechanical Contractor using cables of multi-core arrangement, type "C-Y" or LSF/SWA cable, single core cables in conduit/trunking, or similar approved.

Each indoor room unit shall be factory-fitted with a silent condensate lift pump, the outlet of which shall be connected to nylon-reinforced clear PVC flexible hose, routed along with the refrigeration pipework to discharge into the building drainage system via PVC pipework and waterless traps, as generally shown on the drawing(s).

The GMS cable trays shall also be utilised to carry the interconnecting electrical power supply cables (to indoor room units), the condensate drain pipework, and the controls interconnecting cables – all tie-wrapped along their route.

All electrical installations shall be carried-out, and tested in accordance with the current edition of the IET Wiring Regulations (BS7671).

External condenser unit shall be mounted upon a properly designed and constructed GMS channel type bracket or a manufacturer's proprietary cantilever bracket – fixed securely to the existing masonry wall using expanding or resin-type bolted anchors – in the location as determined by the Mechanical Sub-Contractor's design proposal.
Alternatively, the unit(s) shall be securely fixed to pre-prepared concrete slab or slabs (if mounted at ground level).
Furthermore, any roof-mounted condenser units and pipework (&cable) tray shall be supported on 'Roofpro' or 'Bigfoot' type supports throughout, via GMS H-frame 'goalpost' brackets, and any sacrificial roof protection measures required.

Any heat-pump system external condenser units shall include suitable drain tray and condensate drain pipework (in supported glued PVC), to a suitable, safe drain-away (not onto paths, roads or anywhere that freezing would cause a hazard).

Internal room units shall be suspended from the building fabric ie walls or local ceiling soffite using expanding fixings and where required, on threaded drop-rod.
Under no circumstances, shall the new equipment bear any appreciable weight onto suspended ceilings or plasterboard finishes unless fitted with a plywood backing pattress secured to primary structural wall members.

As a preference, new user controls for the room unit(s) shall be "hard-wired" using the manufacturer's recommended signal cable, which shall be routed along the GMS trays above ceilings, and within flush-fitted PVC conduit & fittings – and located near doorways or as agreed with the CA.

3.26.3. TESTING & COMMISSIONING

All new systems shall be tested, commissioned, and set to work within this project, and in full accordance with the equipment manufacturer's requirements.

The specialist installer shall fill the system with sufficient quantities of additional refrigerant (*and any

lubricants as required), to suit the installed pipework capacity, in addition to any pre-charged amount already present.
The installations shall be rigorously tested and all pertinent system temperatures and pressures (refrigerant and air-side) shall be monitored and assessed to ensure each installation is functioning as expected in the various modes of operation.

Condensate pumps shall be tested using clean water, including over-flow and outlet blocked scenarios.
At commissioning stage, air filters shall be cleaned or replaced as appropriate, if at all soiled from construction site dust.

3.27. AS-INSTALLED MANUALS, RECORD DRAWINGS

It is a requirement of the Mechanical Sub-Contractor within part of his "work to be done", to provide appropriate and adequately detailed documentation to record the works carried out, and for the purposes of guidance to future maintenance for the equipment.

The Mechanical Sub-Mechanical Sub-Contractor shall provide all documentation in two paper copies each contained within a ring-binder, having sections for the following subjects;-

- Content
- Introduction and Description of the Project
- Contact Details for the Mechanical Sub-Contractors
- Details of Project Team and Client
- Details of the materials and components
- Fault Finding Routines
- Maintenance and Inspection Schedules
- Statutory requirements
- As-Installed Drawings

The Mechanical Sub-Contractor shall provide the As-Installed drawings in AutoCad 2016 or later format, and a set of matching Adobe PDF format versions.
All AutoCad drawings shall be provided in accordance with British Standards for CAD Drawing convention.

A data disc containing all the documentation including drawings, shall be provided with each printed manual.
All data files shall be saved as Adobe PDF format, with logical file names – with the exception of the source AutoCAD drawings which shall be DWG format.

3.28. PROVISIONAL SUMS

The Mechanical Sub-Contractor shall include the following itemised & identified provisional sum values within his tender build-up.
These Provisional Sums may or may not be expended during the execution of this project and may not be used as an alternative to any element of the work to be done.
Any sums to be expended will be instructed at the sole discretion of the Contract Administrator.
Sums not expended through Contract Instruction will be deducted from the project final account.

a.	Contingency	£ 2,500.00
b.	Enhancements	£ 1,500.00

SECTION FOUR

TENDER SUMMARY

TENDER SUMMARY – Mechanical Services

Pinner Park School – Reception Extension

The pricing information shall be completed in full by the tenderer and returned with their offer.

Ref	Item	Amount
	Mechanical Services Works	
1.	Stripping Out & Removals – Pipework Services & Insulation	£
2.	Stripping Out & Removals – Ventilation Services	£
3.	Stripping Out & Removals – Above Ground Drainage Services	£
4.	Installation: Hot & Cold Water Services	£
5.	Installation: LTHW & Electric Heating Services	£
6.	Installation: Mechanical Ventilation Services	£
7.	Installation: DX Refrigeration Comfort Cooling Systems inc. Testing & Commissioning	£
8.	Installation: Above Ground Drainage	£
9.	Installation: Thermal Insulation to Pipework Services	£
10.	Testing & Commissioning: Hot & Cold Water Systems	£
11.	Testing & Commissioning: LTHW & Electric Heating Services	£
12.	Testing & Commissioning: Ventilation Systems & Controls	£
13.	As-fitted Drawings and O&M Manuals	£
14.	Project Preliminary Costs	£
	Provisional Sums	
15.	a. Contingency	£ 2,500.00
	b. Enhancements	£ 1,500.00
	+ Sub-Total Provisional Sums	**£ 4,0000**
	Total	£
	v.a.t.	£
	Grand Total	**£**

All prices shall be submitted in GBP Sterling.

Company Name	
Address	

Name	
Position	
Signature	
Date	

SECTION FIVE

EMPLOYER'S REQUIREMENTS
ROOM DATA SHEETS

Pinner Park School Extension
RDS - M1
Mechanical Ventilation & Comfort Cooling

Room No	Room Name	Air Change Rate Per Hour N-Natural S-Supply E-Extract X - Existing		Min. Fresh Air Supply Rate l/s per Person	Number of Occupants	Comfort Cooling	Summertime Resultant Design Temperature (°C)	Casual Heat Gain From Equipment (Sensible kW)	Central Plant	Local Systems	Continuous	Time Scheduled	PIR Plus Extension Timer	Local Lighting Trigger Plus Extension Timer	Local on/off and Speed Controller	Other	External Louvre(s)/Grille(s)	Air Transfer Grille	Max. Services Noise Level (NR)	Comments
001	**Reception**	N	N																	Natural Ventilation via opening doors and windows
002	**Visitor WC**	N	E10										✓							New Centrifugal Extract fan (wall mounted) with PIR operation, adjustable run-on timer, ducted rear outlet and integral shutter. Manf: Vent Axia, Nuaire, Xpelair or similar. Air makeup via door gaps.
003	**Reception Admin**	X	X																	Existing to Remain. No Work Required.
004	**Administation Office**	S6	E6		6	✓	22	1.0		✓		✓					✓		45	New MVHR-based system c/w electric frost heater battery. Plant & ductwork routed within ceiling void. Self-contained controls. Heat recovery bypass in summer. Ductwork all to be insulated. 6x ceiling grilles/diffusers total. AHU Plant to be weatherproof and located externally on rooftop on suitable supports as applicable. Whole external installation to be fully weatherproof. Relocate existing duct/grille from room (now part of 004 Admin Office) - & reinstall within corridor adjacent the lobby.
																				New 'Split' Refrigeration Comfort Cooling System - With Indoor Wall Unit, Outdoor Condenser Unit utilising R32 refrigerant, interconnecting pipework, condensate drainage, wired controls. To meet 100% of the summer fabric, internal and ventilation heat gains. Ventilation rate as specified. Equipment Manf. Daikin.
005	**Circulation / Photocopy**	X	X																	Existing to Remain. No Work Required.
006	**Circulation**	N	N																	Natural Ventilation via opening doors and windows
007	**Covered Circulation Space**	N	N																	Natural Ventilation via opening doors and windows
008	**Office**	N	N																	Natural Ventilation via opening doors and windows
009	**Circulation**	N	N																	Natural Ventilation via opening doors and windows
010	**Hall Lobby**	N	N																	Natural Ventilation via opening doors and windows
011	**Computer Room**	X	X																	Existing to Remain. No Work Required.
012	**Store**	N	N																	Natural Ventilation via opening doors and windows
013	**Private Office**	S10	E10							✓		✓					✓		40	New MVHR-based system c/w electric frost heater. Plant & ductwork routed within ceiling void. Self-contained controls. Heat recovery bypass in summer. Ductwork all to be insulated. 2x ceiling grilles/diffusers total. External weatherproof roof terminals. May form part of a new system serving this room and 004 Admin Office.
014	**Existing WC**	N	E10										✓						45	New Centrifugal Extract fan (wall mounted) with PIR operation, adjustable run-on timer, ducted rear outlet and integral shutter. Manf: Vent Axia, Nuaire, Xpelair or similar. Air makeup via door gaps.

Pinner Park School Extension
RDS - M2
Space Heating

Room No	Room Name	Resultant Room Temperature (°C)	Fresh Air Infiltration Air Changes / Hour (Design)	Fan Convector Units	Ceiling Mounted Radiant Panel	Panel Radiator	LST Radiator	Refrigeration Heat Pump System	Electric Panel Convector	LST Electric Panel Convector	Over Door Air Curtain Heater	Hot Surface Max. Temp. (°C)	TRV and Lock-shield (Rad)	Handwheel and Lock-shield (Rad)	Max. Services Noise Level (NR)	Comments
001	**Reception**	21	4				✓				✓	43	✓		50	Isolate, drain & remove existing radiators & pipework where walls are to be demolished. Install new LST LTHW radiators to meet 100% of the total winter space heat loss. Install new over-door air curtain heater (LTHW) to protect full door width. [ODAC heater to be speed controllable / summer/winter mode/air thermostat/LTC - and have user control unit]
002	**Visitor WC**	X														Existing to Remain. No Work Required.
003	**Reception Admin**	X														Existing to Remain. No Work Required.
004	**Administation Office**	21	2				✓					43	✓			Isolate, drain & remove existing radiators & pipework where existing walls are to be demolished, or to allow new walls to be constructed. Modify and extend existing LTHW heating system suit. Install new LST LTHW radiators & connect via new pipework to existing LTHW heating system & meet 100% of the total winter space heat loss. New radiators to be located under windows and adjacent doorways as a priority.
005	**Circulation / Photocopy**	21	2				✓					43	✓			
006	**Circulation**	18	2		✓											Radiant heating panels mounted to soffite/ceiling. Electrically heated with local smart controls & thermostat (tamper-proof)
007	**Covered Circulation Space**	-	-													Unheated.
008	**Office**	21	1			✓							✓			Install new LTHW radiators to meet 100% of the total winter space heat loss. New radiators to be located under windows and adjacent doorways as a priority. Radiator type & pipework materials to generally match existing in local area.(i.e. Panel Convector Radiators & Mapress (Crimp Fit) Pipework.
009	**Circulation**	18	2		✓											Radiant heating panels mounted to soffite/ceiling. Electrically heated with local smart controls & thermostat (tamper-proof)
010	**Hall Lobby**	21	4			✓							✓			Install new LTHW radiator to meet 100% of the total winter space heat loss. New radiator to be located under windows and adjacent doorways as a priority. Radiator type & pipework materials to generally match existing in local area.(i.e. Panel Convector Radiators & Mapress (Crimp Fit) Pipework.
011	**Computer Room**	X					✓					43	✓			Isolate, drain & remove existing radiators (incl. casings) & pipework below external windows, where temporary doorway to be installed - and set aside carefully for future reinstallation. New radiators to be located under windows and adjacent doorways as a priority.
012	**Store**	X														Existing to Remain. No Work Required.
013	**Private Office**	X														Existing to Remain. No Work Required.
014	**Existing WC**	X														Existing to Remain. No Work Required.

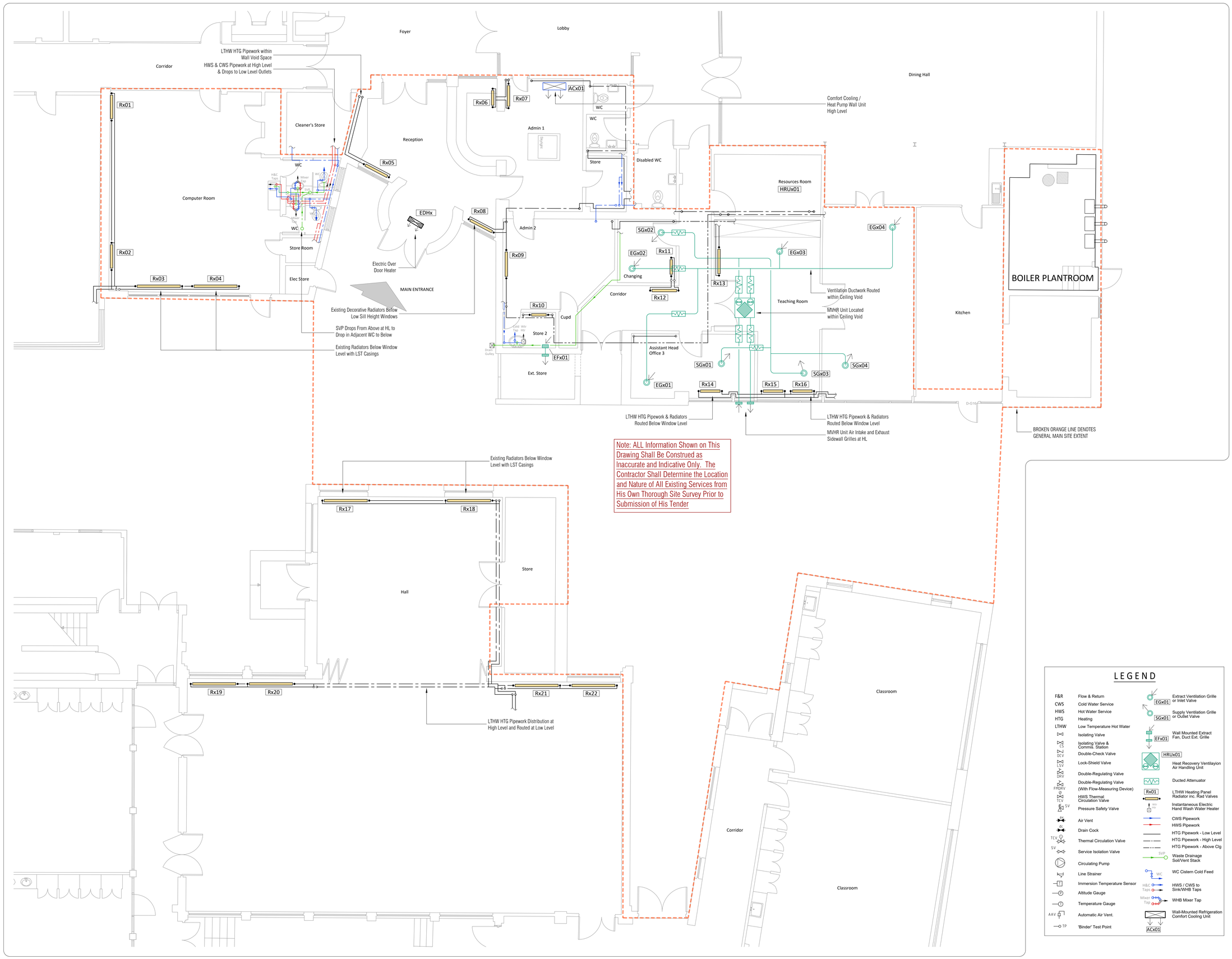
Pinner Park School Extension
RDS - M3
Hot & Cold Water

Room No	Room Name	Sink	Basin	WC	Other	Lab Sink	Fume Cupboard	Mains Cold Water (Drinking)	Local Point of Use Hot Water	Central Plant Hot Water	Hot Water Max. Temp. (°C)	Lab Cold Water Outlet Tap	Comments
001	**Reception**												Install thermal insulation (inc. labelling/direction arrows) to any existing hot & cold water pipework within the defined room, mounted above 2000mm AFFL, and also within voids, ceiling spaces, boxings, service ducts, cupboards, service risers, furniture service spaces, trenches, unheated areas, all within the footprint of the defined room or immediately adjacent (within 500mm) to it.
002	**Visitor WC**		✓	✓						✓	43		Strip Out & Remove Existing HWS & CWS pipework etc serving existing WC & Wash Basin, back to pipework supply branch (replace existing valves or fit new where none exist). Install new CWS & HWS (flow & return) pipework to serve New WC and Wash Basin via local service valves. Install TMV in line with Hot Tap fitted to Wash basin. All new pipework above 2000mm AFFL to be thermally insulated (inc. labelling/direction arrows). All pipework on view to be high quality chrome-plated, with matching fittings and supports. Flexible pipework is prohibited and shall not be used. Mixer tap final connections to be solid or malleable solid copper type. Install thermal insulation (inc. labelling/direction arrows) to any existing hot & cold water pipework within the defined room, mounted above 2000mm AFFL, and also within voids, ceiling spaces, boxings, service ducts, cupboards, service risers, furniture service spaces, trenches, unheated areas, all within the footprint of the defined room or immediately adjacent (within 500mm) to it.
003	**Reception Admin**												No Services
004	**Administation Office**												No Services
005	**Circulation / Photocopy**												Install thermal insulation (inc. labelling/direction arrows) to any existing hot & cold water pipework within the defined room, mounted above 2000mm AFFL, and also within voids, ceiling spaces, boxings, service ducts, cupboards, service risers, furniture service spaces, trenches, unheated areas, all within the footprint of the defined room or immediately adjacent (within 500mm) to it.
006	**Circulation**												No Services
007	**Covered Circulation Space**												No Services
008	**Office**												No Services
009	**Circulation**												No Services
010	**Hall Lobby**												No Services
011	**Computer Room**												No Services
012	**Store**												No Services
013	**Private Office**												No Services
014	**Existing WC**												Existing to Remain. No Work Required.

Pinner Park School Extension
RDS - M4
Above Ground Drainage - Waste & Soil

Room No	Room Name	Kitchen Type Sink	Wash Hand Basin (small)	Wash Hand Basin (large)	WC Pan	Urinal	Fume Cupboard	Laboratory Sink (Chemical)	Kitchen Equipment	Drinking Fountain	Mechanical Plant/Equipment Condensate	Other	Comments
001	**Reception**												No Services
002	**Visitor WC**		✓		✓								Disconnect and remove existing drainage connections serving WC pan and Wash Basin - back to SVP stack & remove connections as necessary. Modify SVP stack with new connections to suit new arrangement (WC/WHB locations) and install new 110mm and 32mm branches respectively, with new final connections, traps and rodding access throughout for all new sanitaryware. Note SVP stack also serves facilities on first floor. Make temporary arrangements for blanking off unised stack connections during works, as required.
003	**Reception Admin**												No Services
004	**Administation Office**												No Services
005	**Circulation / Photocopy**												No Services
006	**Circulation**												No Services
007	**Covered Circulation Space**												No Services
008	**Office**												No Services
009	**Circulation**												No Services
010	**Hall Lobby**												No Services
011	**Computer Room**												No Services
012	**Store**												No Services
013	**Private Office**												No Services
014	**Existing WC**												Existing to Remain. No Work Required.

Note: Refer to Architect's/Surveyor's Details for Any Additions / Changes to Below Ground Drainage & Rain Water Systems



Note: ALL Information Shown on This Drawing Shall Be Construed as Inaccurate and Indicative Only. The Contractor Shall Determine the Location and Nature of All Existing Services from His Own Thorough Site Survey Prior to Submission of His Tender

LEGEND

F&R	Flow & Return
CWS	Cold Water Service
HWS	Hot Water Service
HTG	Heating
LTHW	Low Temperature Hot Water
	Isolating Valve
IS	Isolating Valve & Commis. Station
DCV	Double-Check Valve
LSV	Lock-Shield Valve
DRV	Double-Regulating Valve
PRV	Double-Regulating Valve (With Flow-Measuring Device)
TCV	HWS Thermal Circulation Valve
SV	Pressure Safety Valve
AV	Air Vent
DC	Drain Cock
TCV	Thermal Circulation Valve
SV	Service Isolation Valve
	Circulating Pump
	Line Strainer
T	Immersion Temperature Sensor
P	Altitude Gauge
T	Temperature Gauge
AAV	Automatic Air Vent.
TP	'Binder' Test Point
EGx01	Extract Ventilation Grille or Inlet Valve
SGx01	Supply Ventilation Grille or Outlet Valve
EFx01	Wall Mounted Extract Fan, Duct Ext. Grille
HRUx01	Heat Recovery Ventilayion Air Handling Unit
	Ducted Attenuator
Rx01	LTHW Heating Panel Radiator inc. Rad Valves
	Instantaneous Electric Hand Wash Water Heater
	CWS Pipework
	HWS Pipework
	HTG Pipework - Low Level
	HTG Pipework - High Level
	HTG Pipework - Above Clg
SVP	Waste Drainage Soil/Vent Stack
WC	WC Cistern Cold Feed
H&C Taps	HWS / CWS to Sink/WHB Taps
Mixer Tap	WHB Mixer Tap
ACx01	Wall-Mounted Refrigeration Comfort Cooling Unit

NOTES

NOTICE

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DO NOT SCALE FROM THIS DRAWING

NOTES

1. Do Not Scale From This Drawing.
2. All Positions Are Approximate.
3. Final Locations Of All Equipment Shall Be Determined By Contractor.
4. Contractor Shall Co-ordinate This Equipment With All Other Equipment and Building Elements.
5. All Pipework & Equipment Shall Be Deemed New Unless Stated Otherwise.
6. All Pipework & Ductwork Shall be Insulated as Specified.
7. Drain Cocks, Air Vents, Safety Valve Discharges & Condense Drains Not Generally Indicated However Shall be Fitted in all Cases as Applicable.

No	DATE	REVISION
1	2-6-20	Preliminary Issue - for comment.
A	3-6-20	Tender Issue

Tender Issue

PROJECT
PINNER PARK SCHOOL
RECEPTION EXTENSION

DRAWING TITLE
MECHANICAL SERVICES
EXISTING SERVICES
(INDICATIVE FOR GUIDANCE)

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DATE May 2020
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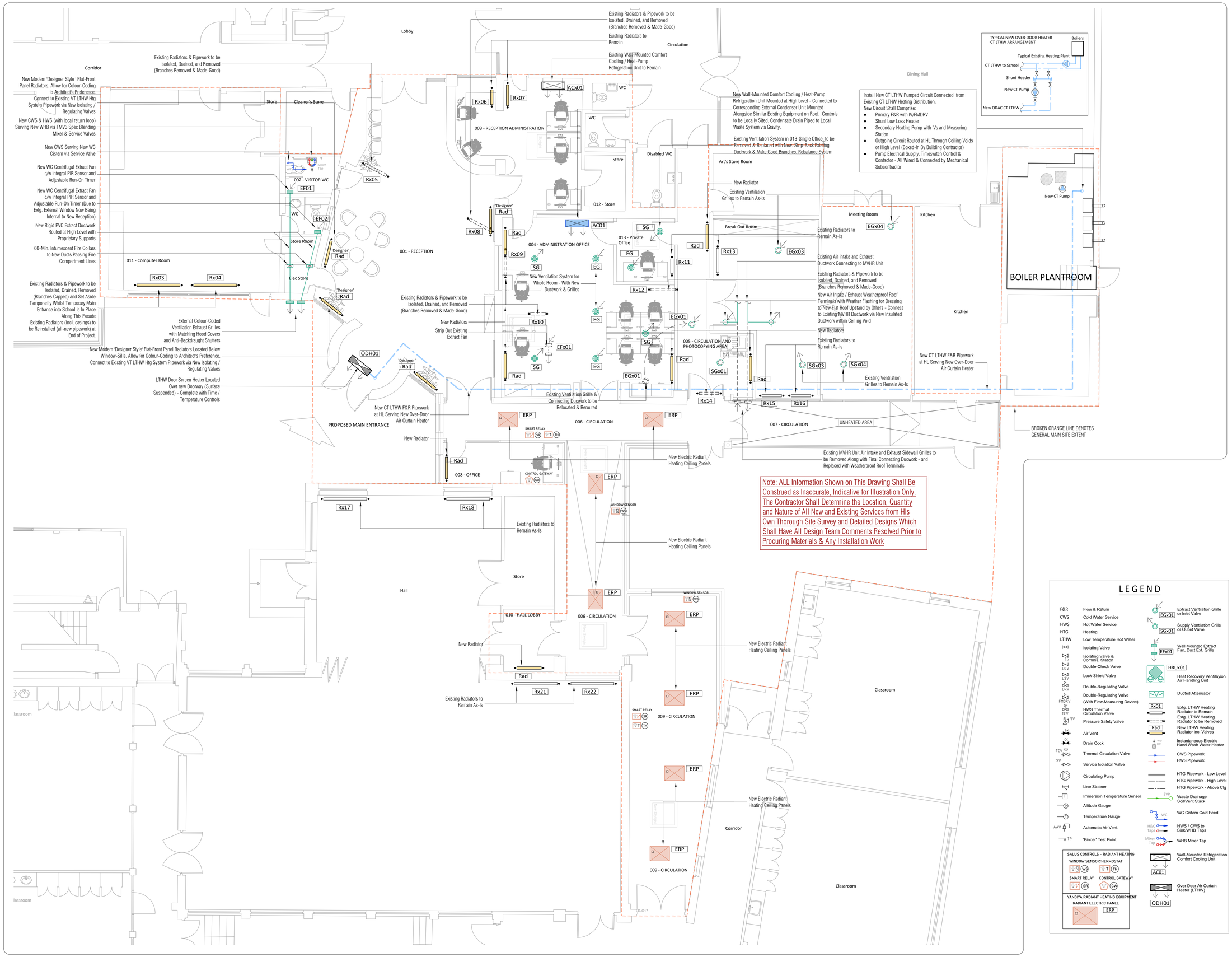
DRAWING No 2007-M01 Rev:A



LEGEND

F&R	Flow & Return
CWS	Cold Water Service
HWS	Hot Water Service
HTG	Heating
LTHW	Low Temperature Hot Water
	Isolating Valve
	Isolating Valve & Commis. Station
DCV	Double-Check Valve
LSV	Lock-Shield Valve
DRV	Double-Regulating Valve
FMDRV	Double-Regulating Valve (With Flow-Measuring Device)
TCV	HWS Thermal Circulation Valve
SV	Pressure Safety Valve
	Air Vent
	Drain Cock
TCV	Thermal Circulation Valve
SV	Service Isolation Valve
	Circulating Pump
	Line Strainer
T	Immersion Temperature Sensor
	Altitude Gauge
T	Temperature Gauge
AAV	Automatic Air Vent.
TP	'Binder' Test Point

SALUS CONTROLS - RADIANT HEATING
WINDOW SENSOR/THERMOSTAT — WS, TH
SMART RELAY — SR
CONTROL GATEWAY — GW
YANDIYA RADIANT HEATING EQUIPMENT
RADIANT ELECTRIC PANEL — ERP

EGx01	Extract Ventilation Grille or Inlet Valve
SGx01	Supply Ventilation Grille or Outlet Valve
EFx01	Wall Mounted Extract Fan, Duct Ext. Grille
HRUx01	Heat Recovery Ventilayion Air Handling Unit
	Ducted Attenuator
Rx01	Extg. LTHW Heating Radiator to Remain
	Extg. LTHW Heating Radiator to be Removed
Rad	New LTHW Heating Radiator inc. Valves
WV HG	Instantaneous Electric Hand Wash Water Heater
	CWS Pipework
	HWS Pipework
	HTG Pipework - Low Level
	HTG Pipework - High Level
	HTG Pipework - Above Clg
SVP	Waste Drainage Soil/Vent Stack
WC	WC Cistern Cold Feed
H&C Taps	HWS / CWS to Sink/WHB Taps
Mixer Tap	WHB Mixer Tap
AC01	Wall-Mounted Refrigeration Comfort Cooling Unit
ODH01	Over Door Air Curtain Heater (LTHW)

NOTES

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NOTES

1. Do Not Scale From This Drawing.
2. All Positions Are Approximate.
3. Final Locations Of All Equipment Shall Be Determined By Contractor.
4. Contractor Shall Co-ordinate This Equiment With All Other Equipment and Building Elements.
5. All Pipework & Equipment Shall Be Deemed New Unless Stated Otherwise.
6. All Pipework & Ductwork Shall be Insulated as Specified.
7. Drain Cocks, Air Vents, Safety Valve Discharges & Condense Drains Not Generally Indicated However Shall be Fitted in all Cases as Applicable.

No	DATE	REVISION
1	2-6-20	Preliminary Issue - for comment.
A	3-6-20	Tender Issue

Tender Issue

PROJECT
PINNER PARK SCHOOL
RECEPTION EXTENSION

DRAWING TITLE
MECHANICAL SERVICES
PROPOSED
HCWS, HEATING, DRAINAGE
VENTILATION & COOLING

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