

SECTION A

TECHNICAL SPECIFICATION

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1 GENERAL DESCRIPTION OF THE CONTRACT

1.1 Scope of Contract Works

This Contract involves the upgrade of the existing heating system in the Youthreach, Castleblayney. The Contractor shall be responsible for employing suitably qualified and experienced specialist sub-contractors to carry out the various elements of the works. The Contractor shall be responsible for project managing and co-ordinating all sub-contractors.

Tenders submitted for only part of the project works won't be permitted and their tender will not be considered.

The Contractor shall include for the supply, delivery, off-loading, erection, connection, testing and commissioning of all plant and materials as indicated on the drawings, described in this specification and as necessary for the complete and satisfactory mechanical services upgrade.

All services shall be provided in accordance with the relevant Standards, Codes of Practice, the Department of Education TGD, Local Authorities and Statutory Bodies requirements. The completed Mechanical Services Upgrade shall be handed over to the Client in a condition suitable for immediate use.

The schedules and drawings accompanying this specification, whilst indicating the extent of the works, do not purport to be Bills of Quantities and do not include such items as fixings, accessories, etc., which shall be supplied together with all other items, whether specifically mentioned or not, necessary to complete the installation in every respect.

Any difference between, or omission from, the said drawings and specification shall not absolve the Contractor from liability to provide a complete installation in accordance to the true meaning and intent of all taken together. The Contractor shall supply and erect everything implied therein requisite to the satisfactory completion and convenient working of the installation.

The Contractor is deemed to have visited the site prior to completing his tender and satisfied himself as to the site conditions, e.g. accessibility and local conditions.

Each service, when complete, shall be tested and commissioned in full accordance with the relevant sections of this specification and the various commissioning procedures lay down by the professional bodies.

Any equipment, appliance or material not shown on the drawings, but mentioned in the specification or vice versa, or any minor details or accessories not shown or specified, but necessary for the proper installation and operation of the contract works, shall be delivered, supplied and installed by the Contractor, without additional expense to the contract.

1.2 Description of Works

The project involves the following scope of works:

1.2.1 Mechanical & Electrical Services

- Disconnect and remove pipework, pumps, and controls from boilerhouse and install a new plantroom fitout except the oil boiler and primary pump.
- Installation of new Heat Pump and upgrade the existing heating system to bivalent heating system.
- Install new Building Energy Monitoring System (BEMS) to control the heating system and monitor fuel use;
- Replace existing heating distribution pipework throughout the school.
- Replace existing radiators.
- Associated electrical works including wiring of plant, valves and sensors from new MCC panel.

Prior to any works commencing:

- Organising furniture and equipment in rooms to allow access to carry out works. Covering and protecting future, IT equipment, smartboards, catering equipment, shelving, etc. with plastic covered to avoid dust and debris collecting;

1.2.2 Builder's Work

- Coring and drilling through walls to cater for mechanical and electrical services;

1.2.3 Cleaning and Decorating

- Decorating and making good damage to building fabric caused during works;
- Carrying out a deep clean of the entire school building on completion.

The Contractor shall be fully responsible for protecting the building structure, building surfaces, and contents throughout the works, e.g. floor coverings, wall and ceiling surfaces, windows and window blinds, woodwork, furniture, electrical equipment, sanitaryware, etc. Electrical equipment, in particular Smartboards, shall be covered to prevent dust ingress. Only light gauge (1,000 / Grade A) clear polythene shall be used to cover and protection furniture and IT equipment.

The Contractor shall also be responsible for any damage caused externally on the school grounds e.g. entrance gates, walls, driveways, kerbing, footpaths, courtyards, lawns and football fields, etc.

Any damage caused by the Contractor or his sub-contractors during the works shall be put right at the contractor's own expense. All rubbish generated during the execution of these works shall be removed from site and disposed of in a manner which does not contravene current Health and Safety Regulations and Local Authority Bye Laws.

2 GENERAL ITEMS

2.1 CE Marking

All equipment shall show and signify compliance by CE Marking being present in a visible location as defined by the applicable directives.

2.2 Contract Supervisor

The Contractor shall engage a site based contract supervisor for the entire duration of the contract. The supervisor shall maintain a presence on site at all times. He shall be responsible for liaison with the engineer and the client. He shall prepare weekly site reports and query lists etc. as required. The contract supervisor shall have a minimum of five years' experience in a contract supervisory role.

2.3 Compliance with Specification

Prior to commencing his works the Contractor, his foreman, purchaser and any other senior personnel who may become involved in the project must read the specification. They shall each sign a standard declaration form stating that they have read and understood the requirements of the specification.

Any ambiguities will be clarified with the engineers and agreed with the contractor prior to signing the declaration form.

The contractor shall note that the engineer will be visiting site occasionally to inspect the works. Any works installed in a manner which is deemed not to be in accordance with the specification will be taken down and reinstalled in the specified manner at the contractors own expense.

2.4 Completion of Work

The contract works shall be carried out with best quality plant, equipment, materials and workmanship in the manner specified and shall be installed, connected up, tested and left in complete operational order to the Engineer's satisfaction, in accordance with the meaning of this Specification.

Any equipment, appliance, material or work not shown on drawings but mentioned in the specification or vice versa or any incidental accessories necessary to make the work complete and perfect in all respects, and ready

2.5 Inspection of Site

Tenderers are advised to visit the site to inspect the extent of the work involved before completing their tender. No additions or variations to the contract due to lack of site environment and conditions will be entertained. They shall contact the School Principal prior at least 7 days before the tender return date in order to arrange a site visit. Tenderers are urged not to visit the site during school hours unless prior approval has been obtained from the School Principal/Engineer.

2.6 Material & Equipment of Alternative Manufacture – “Equal and Approved”

When this specification and/or drawings refer to any item of equipment to be manufactured by a particular and specified manufacturer and no reason is given for exclusive use of such equipment, it shall be clearly understood by the contractor that this is for the purpose of making clear the nature and quality of the equipment required and does not imply that the contractor shall use the named equipment to the exclusion of equipment of other manufacture, provided that such is of equal nature and quality and is approved by the Engineer.

The tenderer must, however, base his tender on the materials specified but may quote separately, in a covering letter, for materials of alternative manufacture at the time of tendering.

The Contractor shall obtain written approval of the engineer for the substitution of materials of an alternative manufacturer.

2.7 Regulations

All plant and materials shall comply in all respects with the requirements of the relevant standards and shall be installed in accordance with the manufacturer's recommendations, CIBSE Guide to Good Practice, Local Authority Bye-Laws, Water Regulations and Health and Safety at Work Order.

2.8 Location of Equipment

The location of pipework and equipment shown on the drawings is diagrammatic and the final location, mounting height, etc. of each item and run of pipe shall be agreed with the Engineer in writing before the commencement of work.

2.9 Definitions of Electro-technical Terms

The definition of electro-technical terms used throughout this specification shall be as outlined in the National Rules for Electrical Installations as published by the Electro-Technical Council of Ireland or (ii) I.E.C. publication 50 "Electro technical Vocabulary" or (iii) I.E.C., B.S. or I.S. Publications, dealing with the particular subjects concerned.

2.10 ETCI National Wiring Rules

The whole of the electrical work shall be carried out in strict accordance with the latest Edition of the ETCI National Wiring Rules for Electrical Installations and any other relevant local, statutory or government authority.

In particular he shall note the specific requirements in relation to the most recent edition of the ETCI Rules (Fourth Edition) and shall ensure that nothing in this tender document or any subsequent post tender instruction, written or verbal, is in contravention of the requirements of these Wiring Rules. All such matters shall be referred to the engineer in writing for clarification and instruction.

2.11 Isolation of Plant and Equipment

Every item of mechanical plant such as pumps, fans, condensers, compressors, production machinery, lifts, hoists etc. and all other miscellaneous fixed equipment shall be connected by means of a local isolation device.

For all 3 phase applications, plantrooms and external locations the isolators shall be IP 54 TP&N, of polycarbonate construction, 'Safetyswitch' as manufactured by MK Electric Ltd. complete with SWA earthing adaptor.

For small single phase items up to 3kW which are located in dry locations, the isolator maybe a 20Amp double pole switch. Such items would include hand driers, water heaters, and small cooking appliances.

Each isolator shall be fitted with a white screw fixed triplex label engraved with 6mm high lettering, stating the plant and circuit reference. An identical label shall be fixed to the item of plant.

3 REMOVAL OF EXISTING SERVICES

3.1 General

The Contractor shall include for disconnecting and removal from site of obsolete services and materials.

The redundant items of equipment/building material shall be removed from site by the Contractor and disposed of in an approved manner complying with current health and Safety and Environmental Health Regulations.

3.2 Site Inspection

The extent of the existing services is not indicated on the drawing. The Contractor shall be deemed to have inspected the site and made an assessment of the work involved prior to submitting his tender. The Contractor is strongly advised to inspect the site before completing his tender. The Engineer will entertain no claims for extras arising out of lack of knowledge of site conditions and site access.

4 **BOILER-HOUSE INSTALLATION**

4.1 **Introduction**

The Contractor shall include for the supply and installation of the complete Boiler Room fitout serving the school as follows:

- Heat Pump
- Circulating pumps
- Expansion vessel
- Autofill unit
- Heating pipework
- Insulation
- Commissioning sets and balance valves.

The Contractor shall be responsible for the supply, installation, commissioning and demonstration of the complete LPHW heating system. He shall be responsible for the performance of the finished LPHW systems.

The LPHW heating system installation shall comply with all relevant standards (IS, BS & EU), as well as best industry practice. It shall be responsibility of the contractor to demonstrate compliance with all relevant standards.

4.2 **Air-to-water Heat Pumps**

The Contractor shall include for the design, supply, installation, testing, commissioning and demonstration of the complete heat pump installation.

The Contractor shall employ a heat pump specialist contractor to design, supply and install the heat pump systems to serve the space heating and hot water. The specialist Contractor shall be trained and accredited by the heat pump manufacturer and shall have at least 8 years' experience in designing and installing air source heat pumps. Final commissioning shall be overseen by the heat pump manufacturer or distributor engineer.

The Contractor shall include for all necessary fittings and controls to successfully complete the installation.

The Air Source Heat Pump (ASHP) & associated systems shall be RHOSS or equal and approved specialist.

The air source heat pump system shall comply in its entirety with all relevant local, national and international standards including but not limited to: EN 14511/1 and /2, EN14825 & EN 16147

- Statutory Instrument S.I. 151 for publically funded procurement equipment
- SEAI Triple E Registered Product

- Accelerated Capital Allowance Tax Relief Scheme
- VDI4640 Part 2 Ground Source Heat Pump Systems
- BS EN 15450 Design of Heat Pump Heating Systems
- BS 6700 Design, installation, testing and maintenance of services supplying water for domestic use
- Building Regulations Technical Guidance Document L – Conservation of Fuel and Energy – Dwellings (Part L Amendment) Regulations 2011
- Building Regulations Technical Guidance Document L – Conservation of Fuel and Energy – Buildings other than Dwellings Regulations 2008
- Heating and Domestic Hot Water Systems for dwellings – Achieving Compliance with Part L 2008 - Section 8 Heat Pumps
- HTM guidelines and best practice design.

It shall carry a CE Declaration of Conformity label.

It shall be responsibility of the Contractor to demonstrate compliance with all relevant standards.

The heat pump **must be listed on the SEAI Triple E Register** for efficient heating products. Where alternative heat pumps are proposed, the tenderer must submit the Triple E Product identifier code of the proposed product at the time of tendering. **Non Triple E Listed products will not be accepted.**

The Contractor shall supply and install a ASHP for the Heating System with a 300L buffer vessel (parallel connection type) as per the schematic drawings. The buffer tank shall be rated for 6 bar operation and shall have a minimum of 100mm of insulation with a thermal conductivity of not greater than 0.023 W/mK.

The heat pumps shall be installed approximately as indicated on the layout drawing. The final location of equipment above the energy centre plantrooms shall be approved by the Structural Engineer and Architect prior to works commencing.

The entire system shall be commissioned by the heat pump supplier in accordance with the manufacturer's recommendations and as listed in relevant building standards. Commissioning certificates for each individual unit citing specific serial number shall be required.

The supplier of the system is to provide the contractor with names and where necessary written evidence of F-GAS qualified internal staff in the suppliers organisation. Sub-contracted F-GAS staff will not be permitted. The supplier must confirm they have suitably qualified internal service and maintenance staff for the supply of this equipment.

The Contractor shall arrange for the supply, delivery, offloading, positioning, installation, commissioning and initial 24 months maintenance of the ASHP on site in accordance with the manufacturer's recommendations and all statutory regulations.

The Contractor shall allow for all piping necessary for the optimum operation of the ASHP system and associated items of plant.

System expansion elements, expansion vessels, safety valves etc. shall be sized and provided by the heat pump designer/supplier in conjunction with the information supplied by the Contractor.

The installer shall be F-Gas qualified in line with Irish regulations. Commissioning of the heat pump control system shall be by either the supplier qualified staff or an approved installer. The Contractor shall allow for any callouts / issues with the heat pump system that arise with the first 12 months after installation.

The Contractor shall be responsible for the entire ASHP installation. This includes the design, installation and commissioning of the entire system including its interaction with associated plant and compliance with relevant standards.

The Consulting Engineer shall be notified 5 working days in advance, in writing, of any testing or installation / commissioning works related to the heat pump system so that attendance at same can be arranged in ample time.

The supplier of the equipment shall provide a site specific electrical schematic detailing the cabling, sensors, outputs and power requirements of the units. A meeting will be required with the heat pump supplier, BMS company, mechanical contractor, electrical contractor and Engineer to discuss the control and wiring requirements.

Each compressor located in the outdoor heat pump shall have a three phase supply via a Type C 32A MCB fed from a suitably sized cable.

Each heat pump shall have an individual shunt pump as required (to be sized by the contractor). This pump will have an individual power supply and be engaged via a 230V output from the controller. Each heat pump shall be connected via two STL cables. One cable is the sensor cable and the second cable is the control cable – these cables shall not be run adjacent to the power cables.

Each controller shall be connected to a cascade control switch via a patch cable to allow a master slave cascade control of this part of the system by the heat pump controllers. The master controller shall be fitted with an outdoor temperature sensor for regulation of the weather compensated circuit. This master controller shall also be linked to a return NTC temperature sensor located inside the separation tank.

The heat pump shall have an internet service monitoring & control facility factory fitted for remote off site control and service monitoring of system.

Inclusion of this shall be confirmed at the time of tender along with any annual / additional costs related to same for the life of the installation. Heat pumps which are not remotely via internet monitored by the supplier after installation will not be permitted in order to provide the client with optimum after sales service going forward.

Off-site monitoring and control shall be to a minimum level of interaction that any command or feature that can be read, adjusted, set, reset or input manually in person on site on the heat pump controller shall be capable of same remotely from the heat pump suppliers / monitoring companies office.

Simple or ON/OFF/ALARM remote control facilities will not be deemed equal or approved.

If alternative equipment is being tendered details of above are to be provided to the Engineer.

The minimum Coefficient of Performance (COP) of each heat pump shall be as follows:

- Space Heating Heat Pump A7°C/W35°C – Minimum COP 4.5 EN

as required by iSBEM (BER software) and calculated in accordance BS EN 14825 and the UK's Department for Communities and Local Government's Non-domestic Heating, Cooling and Ventilation Compliance Guide.

The minimum heat pump SCOPs stated above are absolutely essential in ensuring that the building will achieve NZEB compliance on completion.

4.3 Heating Buffer Vessel

The Buffer Vessel shall be manufactured from stainless steel INOX AISI 316-L to the sizes as indicated on the equipment schedule and on the drawings.

Primary hot water flow and return, secondary flow and return; make-up; vent; relief valve; thermometer; altitude gauge; draw-off cock, dump valve at base suitable for sludge removal and thermostat sockets shall be provided on the Buffer Vessel.

The Tank shall be factory-insulated with 100mm thick polyurethane (C.F.C. free) sprayed-on insulation.

Manufacturer's Hydraulic Test Certificates shall be provided in triplicate.

4.4 LPHW Circulating Pumps and Ancillary Items

The heating circulating pumps shall be glandless inline single head circulating pumps, suitable for pipe-supported installation with integrated electronic speed regulation for constant or variable head control as indicated.

All pumps will be provided with integrated variable speed drives, c/w integral pressure transducers, and associated pressure sensors as standard.

All glandless pumps shall be 'A' rated (EEI <0.23) as a minimum.

All glanded pumps shall have a minimum energy rating of IE2 (EFF1).

All pump VSD's shall be capable of turning down to 0% of total flow/pressure, against a deadhead.

They shall conform to the following materials specification:

- Stator Housing - Fine grain cast iron
- Pump Housing - Fine grain cast iron
- Impellor - Stainless steel

- Rotor can - Stainless steel
- Rotor shaft - Stainless steel
- Bearings - Polished ceramic.

The rotor shall be fully immersed in the system fluid. It shall be accurately machined to fit the stainless rotor can in which it shall rotate freely. The can shall retain the system fluid and shall be automatically vented at the top by, means of an air vent and rotation indicator assembly.

Where variable head pumps are specified adjustments shall be achieved by slip streaming through the pump volute. The adjusting mechanism shall be operated by an adjusting knob in the base of the suction housing that shall be extended to an eccentric diaphragm in the pump volute.

Pumps shall be suitable for water temperatures up to 110°C and 6 bar pressure. Pump installations shall always be carried out with shafts horizontal.

All internal parts shall be highly corrosion-proof and wear resistant and shall be machined for minimal frictional losses. They shall be quiet in operation. Pumps shall be self-lubricating.

Pump sizes up to and including 25mm bore shall be screwed union jointed. Above this size all pumps shall be flange jointed and supplied with matching counter flanges with bolt or studs all to BS 4504.

Pumps shall be fitted with gate type valve on both connections or where fitted beside automatic control valves, common gate valve may be used for isolation of both items. Pumps shall be fitted with plugged pressure tapplings on inlet and outlet connections (between valves).

All pumps shall be clearly marked showing direction of rotation and flow direction. The pump plate shall be clearly marked with manufacturer's name, model, electrical requirements in volts, amps, phasing and frequency in Hertz. Serial number and means of identifying year of manufacture and replacement part requirements shall also be provided.

4.5 Auto Fill Unit-LPHW

The auto filling unit shall be a fully packaged pressurisation unit complete with end suction pumps; pressurisation vessel fitted with removable diaphragm; break tank, cover and ball cock; foot valve; pump control pressure switch; pressure gauge; high and low pressure cut-out switches, hydraulic accumulator and low water protection.

It shall be complete with a Motor Control Centre complete with power on light, run and trip lights, high and low pressure lights, low water level light, door interlocked isolator, automatic pump change-over, B.M.S. interface, base plate, etc.

The expansion vessel shall be appropriately sized to suit the installation.

Pressurisation equipment shall be of packaged construction with provision for simple connection to plant and plant control systems. Where practical it shall be mounted on a common base-frame.

Pressurisation (unit)s and their controls shall be arranged to fail safe.

Provision shall be made for quick-filling the system(s) in parallel with the make-up water system(s)

provided for normal service.

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

4.6 Expansion Vessels

The heating system expansion equipment shall be suitable for operation with LPHW heating flow and return temperatures of 80/60°C.

The domestic hot water expansion equipment shall be suitable for operation with inlet & storage temperatures of 10/70°C.

4.7 Boilerhouse Pipework

The low-pressure hot water (LPHW) pipework shall be mild steel, medium grade to BS 1387 up to 125mm diameter. Over 125mm diameter it shall be steel to BS 3601 of a wall thickness of not less than 6mm.

It shall be new, clean, free from defects, of even bore throughout and delivered to site with the manufacturer's protective coating undamaged. All pipework shall be welded throughout, using B.S. EN 10253 – 1 1999, welding fittings.

All pipework in ducts shall be painted with red oxide by this Contractor. Where pipework passes through walls or floors, it shall be sleeved with metal sleeves, finishing flush with the finished wall or floor surfaces.

The Contractor shall include for all recesses, supports and brackets, including supports for pipework on the timber trusses in the pitched roof etc. The Contractor shall supply and install automatic vents on all high points and drain cocks on all low points, of the pipework system, whether shown on the drawings or otherwise.

All pipework supports shall be in strict accordance with B.S. 3974.

All pipework in the boiler house, ceiling voids, low level, high level floor ducts or roof spaces, shall be welded using B.S. EN 10253 – 1; 1999 welding fittings.

4.8 Plate Heat exchanger

The plate heat exchanger(s) shall comprise corrugated plates with primary and secondary fluid ports, assembled with ring gaskets and plate seals, mounted on a frame having end-support plates, rack and end posts, and clamped together with long bolts and tube washers acting on loose end pressure plates.

End plates should carry screwed connections for piping up to 50mm size and flanged connections for piping 65mm and over. Unless otherwise indicated plates shall be fabricated in Grade 316 Stainless Steel.

The Unit shall consist of a skid mounted Plate Heat Exchanger Package consisting of:

- Plate Heat Exchanger with AISI 316 stainless steel plates as per equipment schedule
- 4 port modulating control valve c/w electric actuator • Industrial quality temperature controller

- LED digital display of system temperature and set point.
- High limit safety shut-down & indication with reset button
- All controls are 24 v low voltage
- Integral base mounting plate
- Single head primary pump
- Single head secondary pump
- Day time clock
- BMS interface signal for common fault on primary/secondary pumps

The frame shall be constructed of mild steel and supports which shall fit the exchanger correctly. Manufacturer's Hydraulic Test Certificates shall be provided in triplicate.

4.9 Hot Water Calorifier

The Contractor shall include for the supply and installation of a domestic hot water calorifier as detailed below.

The domestic hot water calorifier shall be vertical indirect stainless steel cylinder with thermometer to measure the temperature of the secondary hot water, polyurethane hard foam insulation and cased with a coloured PVC cover.

They shall have a storage capacity and recovery rates as stated in the schedules or indicated on the drawings (based on secondary hot water 65°C, Cold water 10°C and boiler primary flow of 80°C). It shall be suitable for a system operating pressure of 2 Bar and shall be tested to 3 Bar

Each domestic hot water calorifier shall be fitted with immersion heaters as scheduled. Immersion heaters above 3 kW shall generally be 3 phase and neutral and shall be controlled by a local isolator contactor unit, which shall be supplied with the immersion. The coil of the contactor shall be controlled by the immersion rod thermostat.

4.9.1 Welded Pipework (under 6.2 bar Working Pressure)

Where it is specified that piping shall be jointed together by welding the contractor shall comply with the following:

- Piping of 50mm bore and below may be oxyacetylene or electric arc welded.
- Piping of 65mm bore and over shall be electric arc welded.

Oxyacetylene welding shall conform to BS 2640, Class II oxyacetylene welding of steel pipelines and pipe assemblies for carrying fluids, and the publication dated 1970 entitled "Welding of Mild Steel Pipework" as issued by the Heating and Ventilating Contractors Association.

Electric arc welding shall conform to BS 2971 Class II metal arc welding of steel pipelines and pipe assemblies for carrying fluids, and the above HVAC Publication.

If requested by the Engineer samples of the filler rod or electrodes to be used shall be submitted to the Engineer for approval before any work commences on site.

The contractor shall make arrangements for the dry storage of filler rods and electrodes to prevent deterioration.

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

The competence of the welder shall be judged in accordance with "Recommended Practice and Test Certificates of Competency for Oxyacetylene and Metal Arc Welds in Mild Steel Pipework" issued by the Heating and Ventilation Contractors Association.

The Contractor shall ensure that all welds are cleaned and protected from rust.

Where tack welds are used to secure alignment, there shall be four equally spaced around the circumference of the pipe. Each tack shall be of the same quality as the final weld, with full penetration at the throat or vee or fillet and of a length equal to twice the pipe thickness. Tack welds shall be examined visually for defects by the welder and if found defective, they shall be removed completely.

The Contractor shall allow in his tender price for radiographic testing of 5% of all welds on BS 1387 heavy weight carbon steel at positions chosen by the Engineer for their inspection during the course of the contract.

Shall any of these welds prove to be defective, the contractor will be required to cut out and renew the completed welds, and further to have radiographed two more welds. If any of these fail it shall be rectified and two further welds radiographed and so on.

Radiographic inspection shall be to API standard 1104, with tolerance doubled.

4.9.2 Welded Branches

The Engineer may, at their discretion, accept the use of welded branches in place of standard butt welding tees. Welded branches will only be accepted if each of the following conditions is observed:

The branch shall be profiled to suit the contour of the main pipe and a hole shall be cut in the latter, having a diameter equal to the bore of the branch in the case of a set-in type branch weld. The branch weld shall be located accurately, tack welded into position and finally welded.

The highest standard of general workmanship, marking, cutting and welding shall be employed in the making of a branch weld. Before any branch welding is carried out the Engineer shall be at liberty to inspect the Contractors technique in this matter. If in the Engineers opinion, the contractor is not capable of making branch welds of sufficiently high quality, standard prefabricated butt-welding tees will be required throughout the installation.

In certain cases, the Engineers may direct the installation of reinforcing pads on a branch weld. These shall be installed by shaping a plate or plates to the contour of the pipe and butting a hole in the plate so that it clears the branch weld. This plate shall be welded to the pipe. Before welding is commenced adequate provision shall be made for the escape of air from the plate by drilling a small diameter hole therein.

4.9.3 Sets

Site made sets, including offsets, shall be made cold in bending machine up to and including 50mm diameter bore. Distorted or flattened sets shall be rejected. Mitred or kinked sets shall not be accepted.

4.9.4 Welding Fittings

Welding fittings shall be mild steel with bevelled edges and shall be of similar actual bore and gauge

to the relevant steel tube and shall be in accordance with BS 1965 where applicable.

Welding branches shall be manufactured branch bend pieces swept, bevelled and contoured for welding to mains. Hole required in the main tube may be cut with oxyacetylene torch provided that flame-cut edge is filed away completely, dressed and cleaned out before welding is commenced.

4.9.5 Painting

All factory-finished items shall be touched up if scratched or chipped. Badly damaged items shall be replaced without charge to the client.

4.9.6 Pipe Supports

All pipe supports, hangers and brackets required to support and control the movement of pipework shall be supplied and erected by the Contractor and shall be fixed to the building structure independent of plant and equipment. The Contractor shall obtain the approval of the Engineer of the type and spacing of the supports, hangers and brackets prior to erection.

Pipework shall be supported adequately and in such a manner as to permit free movement due to thermal expansion and contraction. Where pipes are thermally insulated the insulation shall be carried through the support. Vapour barriers shall not be pierced or damaged.

All sharp edges and cut ends on pipe supports, brackets, etc. shall be suitably protected. Pipework shall be supported at a change in direction unless other agreed with the Engineer. Pipework supports shall be arranged as near as possible to the joints.

Supports on horizontal pipework shall be spaced at not more than the following intervals: -

Horizontal Steel Pipework Support Spacings	
Pipe Size (mm)	Support Interval (mm)
15	1800
20	2400
25	2400
32	2400
40	2400
50	2400
65	3000
80	3000
100	3000
125	3700
150	4500
200	6000
250	6500
300	7000

Support on vertical pipework shall be spaced at not more than the following intervals: -

Vertical Steel Pipework Support Spacings

Pipe Size (mm)	Support Interval (mm)
15	2400
20	3000
25	3000
32	3000
40	3700
50	3700
65	4600
80	4600
100	4600
125	5500
150	5500
200	8500
250	9000
300	10000

4.9.7 Pipe Sleeves

In all cases where pipes pass through walls, non-load bearing partitions, floors, ceilings and footings, sleeves shall be provided and it shall be ensured that the sleeves are correctly built-in. Sleeves shall in no case be used as pipe supports, a free annular space always being provided.

4.9.8 Insulation and Cladding

The Contractor shall include for insulating all heating pipework in the boilerhouse.

All heating pipework shall be fully insulated and shall comply with Technical Services Document Building Regulations providing a thermal conductivity of not greater than 0.035 w/mK. Pipework insulation shall comply with B.S. 5422, 2001 & BS EN ISO 12241: 1998.

Boiler house pipework shall be insulated with Armaflex Class 0 insulation

The pipework insulation shall be comprised of rigid preformed pipe sections, wrapped in factory applied reinforced aluminium foil laminate complete with integral self-adhesive lap and light gauge aluminium bands at not more than 450mm centres. Pipework insulation shall be 25mm for pipes up to 35mm and 30mm for pipes up to 54mm.

The Contractor shall ensure that all surfaces are clean and dry before insulation is applied.

All piping and equipment shall be tested and approved before insulation.

Insulation thickness shall be as follows: -

- Up to 19mm dia. 25mm thick insulation
- 25mm dia. to 32mm dia. 25mm thick insulation
- 38mm dia. to 50mm dia. 32mm thick insulation
- Over 50mm dia. 40mm thick insulation.

Insulation valve jackets shall be provided on all primary and secondary heating circuits to minimise heat loss. Jackets shall be appropriately sized for each valve and be secured with heavy duty Velcro.

4.10 **Commissioning Sets and Balancing Valves**

The contractor shall include for the supply and installation of commissioning sets and balancing valves as required to enable complete commissioning of the entire heating system.

The Contractor shall supply, install and commission double regulating balancing valves at each motorised valve position and elsewhere as indicated on the drawings and as necessary to ensure the proper running of the heating systems.

Double regulating valves shall be of Tour & Anderson manufacture and of the following types;

- Up to 65mm diameter MD41
- 80mm and larger MD54

For accurate measurement of the system the minimum distance of straight shall be 10 times the pipe diameter upstream to the flow measuring device and 5 times the pipe diameter downstream of the flow-measuring device to prevent false readings due to turbulence.

A gate valve shall be installed on the flow and return at each commissioning set location for isolation purposes.

Regulating valves, orifice units and commissioning sets shall be fitted with Binder Twinlock test plugs.

The manufacturing tolerances shall ensure a main flow rate of water within +/- 5% of a given pressure differential measurement on a manometer. Commissioning sets shall be selected against their relative flow rate to ensure that the minimum pressure signal as recommended by the valve manufacturer is obtained to ensure accurate readings.

4.10.1 **Dosing Pots**

The contractor shall supply and install 1 no. 100L chemical dosing pot as manufactured by Chempack. The pot shall come complete with fill point and all necessary isolating valves. Dosing pot shall be securely bracketed to the wall.

Prior to practical completion, suitable corrosion inhibitor shall be added (at a 5% system content ratio) to the system by a specialist sub-contractor. The mechanical contractor shall note all types of heat emitters and heating plant associated with the system. The type of inhibitor used shall not adversely affect such equipment.

4.10.2 **Isolation and Regulation**

Valves, cocks and stop taps for isolation and/or regulation shall be provided where shown in the drawings and on the mains to isolate major sections of distribution, on the base of all risers and droppers except in cases, where one item of apparatus only is served which has its own local valve or stop tap, on all sub-circuits of closed systems, on points of pipe connection of all items of apparatus and equipment except where the item could conveniently be isolated or regulated by valves provided for other adjacent items and on draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

4.10.3 Commissioning Points

'Binder' type tappings for commissioning purposes shall be provided, numbers and locations to be agreed with Engineer.

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

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

4.10.4 Strainers

Bronze 'Y' type pattern strainers shall be used on pipelines up to 54mm as scheduled and cast iron strainers shall be used on pipelines over 54mm as scheduled.

All strainers shall have a mesh of an approved size and shall be suitable for the working pressure of this system to which they are installed. Strainer shall be flanged on sizes of 65mm and over and shall be provided with drain facilities in the clean out connection at the bottom of the body construction. Strainers shall be fitted with isolating valves upstream and downstream to facilitate maintenance.

4.10.5 Air Separators

Air separators shall be flexcon Type S as manufactured by Flamco or approved equal. The separator shall be complete with an auto vent, shut off valve and shall be installed as per manufacturer's instructions. Baffles shall not be able to re-entrain the separated water.

4.10.6 Location of Pressure Gauge Points

A female screwed outlet on the pipelines and a gauge cock for pressure gauge points shall be used.

Pressure gauge points shall be located where shown on the drawings, on suction and delivery sides of every pump, on flow and return connections to air/liquid heat transfer coils, including fan coil units on connections to heater batteries of storage and non-storage calorifiers and on point of entry of each pipeline into Plant Rooms.

4.10.7 Location of Temperature Tapping Points

For temperature tapping points a female screwed outlet shall be used on the pipeline and fitted a thermometer pocket.

Where thermometers are not fitted permanently a blanking plug shall be used in the open of the pocket.

Pockets shall be generally inserted into pipelines at right angles to the pipeline axis. On pipelines, up to 32mm size, the pipeline must be locally enlarged to at least 80mm size or the pocket may be inserted at a bend or inclined to the pipeline axis.

At least 75mm of the thermometer pocket shall be in contact with the pipeline contents.

Temperature tapping points shall be located where shown on the drawings, on connections to air/liquid heat transfer coils, on connections to heater batteries of storage and non-storage calorifiers

and on point of entry of each pipeline into Plant Room.

4.10.8 Automatic Air Eliminators

Bronze automatic air eliminators shall be used with integral lockshield valve on inlet and check valve on outlet, manufactured to facilitate grit removal whilst in service.

Screwed female connections shall be provided on pipelines of all sizes.

Integral 10mm hard soldered copper discharge pipeline shall be provided.

Air release pipes shall be run to discharge at the nearest suitable visible safe point.

4.10.9 Drains

Drain cocks, not less than 15 mm, with hose connections, shall be fitted at low points in the pipework distribution systems and local to items of equipment and headers.

Drain valves shall be fitted to common flow and common return lines and shall be of the same size as the largest pipe size of any sub-circuit.

Drain valves, shall be fitted to facilitate flushing and cleaning of pipework where indicated on the drawings and where required. Drain valves shall be bronze lockshield globe or gate valves to BS 5154, with hose union connector.

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

4.10.10 Tundishes

Tundishes shall be fabricated from 3mm thick mild steel plate, to give a large end diameter of 100mm and a small end diameter of 25mm with an included apex angle of 30 degrees. Weld a 25mm female screwed boss to the small end. Galvanised after manufacture.

Pressure relief or combined pressured and temperature relief pattern valves shall be used to the appropriate British Standards.

Safety valves for boilers, heating calorifiers and all pressure vessels shall be provided irrespective of whether shown on the drawings or not.

Safety valves for steam, HTHW and MTHW shall be as indicated on the drawings and the Specification.

4.10.11 Test Points, Gauges and Thermostat Pockets

Every heat generator or heat exchanger unit shall have no less than one temperature gauge and one pressure gauge for efficient control and running.

Each main branch circuit leaving a heat generator or heat exchanger plant room shall be fitted with a temperature gauge and pressure gauge on the flow and a Binder Twinlock test plug on the flow and return.

In order that the installations may be accurately balanced and set to work, test plug points for temperature and pressure tests shall be provided on flow and return connections to all items of equipment and around mixing valves as shown on our drawings.

Test plug points shall consist of connections made into the pipework and fitted with a Binder Twinlock test plug (Binder test points shall not be used on high pressure systems or steam). The test plugs shall be extended to the surface of any insulation applied to the pipework.

Temperature test pockets shall be located and be of sufficient depth as to ensure a true reading of the fluid temperature. Where the pipework size is below 42mm, the pipework accommodating the test pockets shall be increased locally to 50mm so as not to affect the flow rate and response of the gauge/thermostat. Pockets shall be filled with mineral oil and the thermometers fixed so that the tails are truly subjected to the temperature of the fluid to be measured.

Boilers shall have a minimum of a flow temperature gauge, a return temperature gauge and a pressure gauge. Non-storage water/water heat exchangers shall have flow and return temperature gauges on both primary and secondary sides with one pressure gauge on the secondary shell side. Steam heat exchangers shall be as for water/water with additional pressure gauges on primary circuits.

Circulating pumps shall have pressure gauges on both suction and delivery connections.

Except where gauges form part of a 'packaged unit' they shall be no less than 100 mm diameter for mounting heights up to two metres from floor level and 150mm diameter above two metres.

All temperature gauges shall comply with BS 5235, dial type mercury in steel, and shall be installed with removable brass pockets filled with conductive gel.

All pressure gauges shall comply with BS EN 837-1:1988, and shall be complete with syphons and gauge cocks and shall have 10mm connections. Syphons shall be of the same material as the pipework.

The proposed calibration range for all gauges shall be submitted for approval prior to ordering.

All capillary tubes to remote gauges shall be supported upon their entire length, including the final connection to the equipment, on PVC coated tray.

4.10.12 By-Passes

Fixed by-passes shall be provided around all items of plant, equipment or ancillaries which may be subject to damage during flushing or testing and commissioning.

4.10.13 Vibration Isolation

All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be purpose designed and selected to suit the machinery.

Where mat type isolation materials are used, the Contractor shall supply the materials and be responsible for their correct location; all other vibration isolators shall be supplied and installed by the Contractor.

For pumps and water distribution systems, purpose-designed flexible connections shall be provided to minimise the transmission of vibration. The connections shall be compatible with the tube materials and methods of jointing and the fluid handled in the system.

4.10.14 Expansion Bellows

The expansion bellows shall be provided to absorb the movement of the pipelines as fabricated by one of the scheduled firms to BS 6129 and ensure compatibility with the pipeline service and materials. When installing manufactured expansion loops or bellow joints, the manufacturer's installation recommendations shall be observed in every respect.

On Low Pressure systems single wall, convoluted, stainless steel bellows with internal sleeves shall be used, and screwed or welded connections up to 50mm or flanged connections over 50mm

On Secondary Low pressure systems single wall, convoluted, stainless steel bellows with internal and external sleeves shall be used, and screwed connections up to 50mm or flanged connections over 50mm

The expansion bellows shall be installed with great care to ensure no misalignment of the bolt holes and mating flanges and ensure that heat from welding process does not affect bellow materials.

Pre-stress shall only be in accordance with the manufacturer's instructions. Before expansion load is applied any temporary installation, bars shall be removed.

When pressure testing pipework distribution it shall be ensured that the test pressure will not damage the bellows, anchor points, guides and the building structure. Spacer pieces shall be fitted in place of bellows, during any pipeline testing which may affect bellows.

5 LOW PRESSURE HOT WATER (LPHW) HEATING SYSTEM

5.1 Introduction

The Contractor shall include for the supply and installation of new LPHW distribution pipework as indicated on the drawings.

5.2 Pipework

All new low-pressure hot water (LPHW) pipework shall be mild steel, medium grade, to B.S. 1387, 1985. It shall be new, clean, free from defects, of even bore throughout and delivered to site with the manufacturer's protective coating undamaged. All pipework shall be welded throughout, using B.S. EN 10253 – 1; 1999, welding fittings. Particular care shall be taken to protect finishes, including timber roof trusses when welding.

All pipework in ducts shall be painted with red oxide by this Contractor. Where pipework passes through walls or floors, it shall be sleeved with metal sleeves, finishing flush with the finished wall or floor surfaces.

All pipe supports, hangers and brackets required to support and control the movement of pipework shall be supplied and erected by the Contractor and shall be fixed to the building structure independent of plant and equipment. The Contractor shall obtain the approval of the Engineer of the type and spacing of the supports, hangers and brackets prior to erection.

Pipework shall be supported adequately and in such a manner as to permit free movement due to thermal expansion and contraction. Where pipes are thermally insulated the insulation shall be carried through the support. Vapour barriers shall not be pierced or damaged.

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

Pipework shall be supported at a change in direction unless other agreed with the Engineer. Pipework supports shall be arranged as near as possible to the joints.

In all cases where pipes pass through walls, non-load bearing partitions, floors, ceilings and footings, sleeves shall be provided and it shall be ensured that the sleeves are correctly built-in. Sleeves shall in no case be used as pipe supports, a free annular space always being provided.

All heating pipework shall be tested to 700 kPa and held drop tight at this pressure for a duration of 1 hour. The tests shall be only considered valid if witnessed by the Engineer or Client representative and certified accordingly.

All heating pipework circuits shall be balanced and set to design flow rates, utilising dynamic constant pressure balancing valves.

5.3 Pipe Supports

All pipe supports, hangers and brackets required to support and control the movement of pipework shall be supplied and erected by the Contractor and shall be fixed to the building structure independent of plant and equipment. The Contractor shall obtain the approval of the Engineer of the type and spacing of the supports, hangers and brackets prior to erection. Proprietary standoff brackets shall be used where supporting pipework of concrete walls and roofs.

Pipework shall be supported adequately and in such a manner as to permit free movement due to thermal expansion and contraction. Where pipes are thermally insulated the insulation shall be carried through the support. Vapour barriers shall not be pierced or damaged.

Pipework shall be isolated from metal unistrut support systems using an insulated material such as Unicushion.

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

Pipework shall be supported at a change in direction unless other agreed with the Engineer. Pipework supports shall be arranged as near as possible to the joints, and the distance between pipe supports measured along straight runs shall be in accordance with manufacturer's recommendations.

Supports on horizontal pipework shall be spaced at not more than the following intervals: -

Horizontal Steel Pipework Support Spacings	
Pipe Size (mm)	Support Interval (mm)
15	1800
20	2400
25	2400
32	2400
40	2400
50	2400
65	3000
80	3000
100	3000
125	3700
150	4500
200	6000
250	6500
300	7000

Support on vertical pipework shall be spaced at not more than the following intervals: -

Vertical Steel Pipework Support Spacings	
Pipe Size (mm)	Support Interval (mm)
15	2400
20	3000
25	3000
32	3000
40	3700
50	3700
65	4600
80	4600
100	4600
125	5500
150	5500
200	8500
250	9000
300	10000

5.4 Pipe Sleeves

In all cases where pipes pass through walls, non-load bearing partitions, floors, ceilings and footings, sleeves shall be provided and it shall be ensured that the sleeves are correctly built-in. Sleeves shall in no case be used as pipe supports, a free annular space always being provided.

Sleeves shall be formed from a single piece of pipe and shall project 10mm above the finished floor level but shall be flush with the underside of the floor slab. In walls, they shall project approximately 5mm on either side of the finished wall surface.

Sleeves shall be fabricated from the pipeline materials, except in load bearing walls which shall be from cast iron. Sleeves shall be of pipe cuttings properly reamed, cleaned and trimmed at 90° to bore.

The sleeves shall not protrude from the face of the building fabric except when passing through waterproof building fabric where flange sleeves which protrude 100mm shall be used.

Pipework, sleeves and fire stopping shall be installed to meet the requirements of the building regulations and to the approval of the building inspector.

Inside diameter of sleeves shall be not less than 12mm larger than the outside diameter of the pipe, except where pipes pass through load-bearing walls or footings where sleeves shall be 100mm larger than the outside diameter of the pipe.

For pipes which change direction over size sleeves, the size larger than normal, shall be fitted to allow for expansion.

In occupied spaces, fit Zinc Alloy Die cast masking plates fixed with matching screws shall be fitted.

Annular space shall be caulked with an intumescent materials or similar suitable materials.

The thermal movement shall not be impeded by the sleeve, caulking or masking plate.

Chilled water and cold water pipework shall be proved with sleeves of such size as to allow the thermal insulation, at full thickness, to pass through whilst maintaining the continuous Vapour Seal. The type of insulation shall become mineral wool with Vapour Seal for the thickness of the wall.

5.5 Insulation and Cladding

All heating pipework, except where exposed at low level, or where dropping to low level, shall be fully insulated and shall comply with Technical Services Document Building Regulations providing a thermal conductivity of not greater than 0.035 w/mK. Pipe work insulation shall comply with B.S. 5422, 2001 & BS EN ISO 12241: 1998. All pipe work insulation shall be Class 0 fire rated.

The pipework insulation shall be comprise of rigid preformed pipe sections, wrapped in factory applied reinforced aluminium foil laminate complete with integral self-adhesive lap and light gauge aluminium bands at not more than 450mm centres. Pipework insulation shall be 25mm for pipes up to 35mm and 30mm for pipes up to 54mm.

The Contractor shall ensure that all surfaces are clean and dry before insulation is applied. The insulation shall be dry before and during application.

All piping and equipment shall be tested and approved before insulation.

Insulation thickness shall be as follows: -

- | | |
|--------------------------|-----------------------|
| • Up to 19mm dia. | 25mm thick insulation |
| • 25mm dia. to 32mm dia. | 25mm thick insulation |
| • 38mm dia. to 50mm dia. | 32mm thick insulation |
| • Over 50mm dia. | 40mm thick insulation |

5.6 Insulation of Valves and Flanges

Valves and flanges within ceiling voids and other hidden areas shall be enclosed in purpose made covers, comprising mineral wool blanket, sandwiched within glass fabric coated with silicone rubber. The covers are to be demountable and shall be secured by 'Velcro pads' or nylon pull cords.

5.7 Commissioning Sets and Balancing Valves

The Contractor shall supply, install and commission double regulating balancing valves at each motorised valve position and elsewhere as indicated on the drawings and as necessary to ensure the proper running of the heating systems.

Double regulating valves shall be of Tour & Anderson manufacture and of the following types;

- Up to 65mm diameter MD41
- 80mm and larger MD54

For accurate measurement of the system the minimum distance of straight shall be 10 times the pipe diameter upstream to the flow measuring device and 5 times the pipe diameter downstream of the flow-measuring device to prevent false readings due to turbulence.

A gate valve shall be installed on the flow and return at each commissioning set location for isolation purposes.

Regulating valves, orifice units and commissioning sets shall be fitted with Binder Twinlock test plugs.

The manufacturing tolerances shall ensure a main flow rate of water within +/- 5% of a given pressure differential measurement on a manometer. Commissioning sets shall be selected against their relative flow rate to ensure that the minimum pressure signal as recommended by the valve manufacturer is obtained to ensure accurate readings.

5.8 Dynamic Pressure Independent Control Valves

Dynamic Pressure Independent Control Valves shall be electronic, dynamic, modulating 2-way control devices. They shall accurately control flow, independent of system pressure fluctuation.

Maximum flow setting shall be adjustable to a minimum of 50 different settings with the range of the valve size. Valve actuator housing to be rated to IP 44.

Actuator shall be operated by a 24V DC motor, and shall accept 2-10V DC, 4-20mA, 3-point floating or pulse width modulation electric signal and shall include a resistor to facilitate any of these signals.

External LED readout of current valve position and maximum valve position setting shall be available.

Valve housing for valve sizes 15-40mm shall be constructed of forged ASTM (CuZn39Pb2) brass rated at no less than 2500kPa static pressure and 120°C.

Valve housing for valve sizes 50-150mm shall be constructed of Ductile Iron ASTM A536-65T, Class 60-45-18 rated at no less than 4000kPa static pressure and 120°C.

Valve housing shall be double union construction with a range of pipe connections available for the appropriate pipe size.

Optional dual pressure/temperature test plugs for verifying accuracy of flow performance shall be available for all valve sizes.

Flow regulation unit shall consist of stainless steel and hydrogenated acrylonitrile butadiene rubber and shall be capable of controlling flow within +/- 5% of each rated flow.

Flow regulation unit shall be accessible, for maintenance.

The Mechanical Contractor shall provide a numeric tag for each pressure independent control valve to allow for random testing of design flow temperature and pressure. Tags shall be of aluminium material and 50mm x 25mm in size indicating number, production date and pressure differential range.

5.9 Isolation and Regulation

Valves, cocks and stop taps for isolation and/or regulation shall be provided where shown in the drawings and on the mains to isolate major sections of distribution, on the base of all risers and droppers except in cases, where one item of apparatus only is served which has its own local valve or stop tap, on all sub-circuits of closed systems, on points of pipe connection of all items of apparatus and equipment except where the item could conveniently be isolated or regulated by valves provided for other adjacent items and on draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

5.10 Commissioning Points

'Binder' type tappings for commissioning purposes shall be provided, numbers and locations to be agreed with Engineer.

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

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

5.11 Automatic Air Eliminators

Bronze automatic air eliminators shall be used with integral lockshield valve on inlet and check valve on outlet, manufactured to facilitate grit removal whilst in service.

Screwed female connections shall be provided on pipelines of all sizes.

Integral 10mm hard soldered copper discharge pipeline shall be provided.

Air release pipes shall be run to discharge at the nearest suitable visible safe point.

5.12 Drains

Drain cocks, not less than 15 mm, with hose connections, shall be fitted at low points in the pipework distribution systems and local to items of equipment and headers.

Drain valves shall be fitted to common flow and common return lines and shall be of the same size as the largest pipe size of any sub-circuit.

Drain valves, shall be fitted to facilitate flushing and cleaning of pipework where indicated on the drawings and where required. Drain valves shall be bronze lockshield globe or gate valves to BS 5154, with hose union connector.

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

5.13 Tundishes

Tundishes shall be fabricated from 3m thick mild steel plate, to give a large end diameter of 100mm and a small end diameter of 25mm with an included apex angle of 30 degrees. Weld a 25mm female screwed boss to the small end galvanised after manufacture.

Pressure relief or combined pressured and temperature relief pattern valves shall be used to the appropriate British Standards.

Safety valves for boilers, heating calorifiers and all pressure vessels shall be provided irrespective of whether shown on the drawings or not.

Safety valves for steam, HTHW and MTHW shall be as indicated on the drawings and the Specification.

5.14 By-Passes

Fixed by-passes shall be provided around all items of plant, equipment or ancillaries which may be subject to damage during flushing or testing and commissioning.

5.15 Vibration Isolation

All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be purpose designed and selected to suit the machinery.

Where mat type isolation materials are used, the Contractor shall supply the materials and be responsible for their correct location; all other vibration isolators shall be supplied and installed by the Contractor.

For fans and air distribution systems flexible joints shall be provided to minimise the transmission of vibration. For pumps and water distribution systems, purpose-designed flexible connections shall be provided to minimise the transmission of vibration. The connections shall be compatible with the tube materials and methods of jointing and the fluid handled in the system.

6 **RADIATORS & RADIANT PANELS**

6.1 **Introduction**

The Contractor shall include for the supply and installation of all radiators and radiant panels as indicated on the drawings and as scheduled elsewhere within this specification.

6.2 **Radiators**

The radiators shall be the horizontal steel panel type. They shall be of the size and output as detailed in the accompanying Equipment Schedule.

Each radiator shall be complete with an isolating valve with hand wheel on the flow connection and lockshield valve on the return connection and concealed headers.

Each radiator shall be provided with flow and return radiator valves. A recessed key operated air vent and screw-to-wall brackets.

Radiators shall comprise rigid uniform units of welded construction completely free from sharp or burred edges, with screwed connections for valves and air cocks. Radiators having a perceptible degree of distortion will not be accepted and all units shall conform to the requirements of BS 3528.

Radiators shall be manufactured in accordance with the requirements of BS EN 442 and shall be of a robust quality from cold rolled steel plate with a minimum standard wall thickness of 1.5mm. All shall can withstand a static head of 3.5 bar. A space of 150mm between the floor and the bottom of the radiator shall be provided. Each radiator shall be supported by the manufacturer's purpose made concealed top stays and brackets and where special brackets are required they shall be supplied and fixed by the Contractor and be capable of horizontal and vertical adjustment.

Commissioning data shall include for measured water flow rates to each individual emitter.

Radiators shall be supplied with powder coated RAL 9010 white finish as standard. **Radiators shall have a minimum manufacturer's warranty of 5 years.**

6.3 **Radiator Valves**

Each radiator shall be provided with an angle or straight valve on the flow inlet and an angle or straight pattern closed lockshield valve on the return outlet.

Closed lockshield radiator valves shall be bronze to BS 2767 with C.P. finish as manufactured Crane Ltd or equal and approved. The Contractor shall supply and leave onsite 4 no. P101 keys for removal of the security screw of the lockshield cover. The double regulating feature for angle lockshield valves shall be set during system commissioning.

Wheel-head valves shall be bronze to BS 2767 with a C.P. finish as manufactured Crane Ltd or equal and approved.

All radiator valves shall be of the union type with the inlet thread to BS 21 and a polycarbonate hand wheel or lockshield cover.

A thermostatic radiator valve (TRV) with a C.P. finish shall be fitted to the flow inlet or radiators where indicated on the drawings or outlined in the Equipment Schedule. **TRVs shall have a minimum manufacturer's warranty of 5 years.**

The contractor shall supply and fit chromium plated, clip-on floor and wall plates, where heating pipework passes through floors and walls. Plates shall be fully sized and pipework shall be arranged to suit full sized plates.

At practical completion and in addition to handover documentation the following spare parts and items of equipment shall be provided for use by the client:

- 10 No. Lockshield valve keys
- 10 No. Air bleed valve keys
- No. Handwheel valve.

6.4 Radiant Panels

The radiant panels shall be the horizontal steel panel type. They shall be of the size and output as detailed in the accompanying Equipment Schedule.

Each radiant panel or shall be complete with an isolating valve with hand wheel on the flow connection and lockshield valve on the return connection.

Each Radiant Panel shall be provided with flow and return Radiant Panel valves. A recessed key operated air vent and suspension chains or installation frames where mounted in plastered ceilings.

Radiant Panels shall comprise rigid uniform units of welded construction completely free from sharp or burred edges, with screwed connections for valves and air cocks. Radiant Panels having a perceptible degree of distortion will not be accepted and all units shall conform to the requirements of BS 3528.

Radiant Panels shall be manufactured in accordance with the requirements of BS EN 442 and shall be of a robust quality from cold rolled steel plate with a minimum standard wall thickness of 1.5mm. All shall can withstand a static head of 3.5 bar. Each Radiant Panel shall be supported by the manufacturer's purpose made brackets. Commissioning data shall include for measured water flow rates to each individual emitter.

Radiant Panels shall be supplied with powder coated RAL 9010 white finish as standard. **Radiant Panels shall have a minimum manufacturer's warranty of 5 years.**

6.5 Radiant Panel Valves

Each Radiant Panel shall be provided with a volume flow control valve on the flow inlet and a lockshield valve on the return outlet.

6.6 Testing

The system shall be tested to 6 Bar for a minimum duration of 24 hours to confirm that a stabilised minimum pressure of 3 Bar is held in the system.

7 BUILDING ENERGY MANAGEMENT SYSTEM (BEMS)

7.1 Introduction

The Contractor shall include for the supply and installation of a new Building Energy Management System (BEMS) to control the heating system and to monitor and target energy and water use.

7.2 Boilerhouse Motor Control Centre (MCC)

The main mechanical plant items installed throughout the building shall be controlled by the boilerhouse MCC panel.

A Building Management System (BMS) outstation shall be provided in the boiler house control panel and linked to a front-end display on the PC in the principal's office.

The boilerhouse MCC panel shall be custom-built low voltage switchgear assembly manufactured in accordance with IEC 439, Form 2 and the ETCI Code of Practice.

The housing shall be sheet steel minimum thickness 1.5mm, electrolytic galvanised with raised doors and sealing profile. Glanding plates shall be supplied at top and bottom. It shall be suitable for surface wall mounting. It shall have an ingress protection rating of at least I.P. 54.

Current switches shall be mounted within the MCC panel to monitor the run status of all pumps, and valves and wired separately as inputs to the MCC.

Each motor starter shall be complete with MCB, contactor and thermal overload, selected to provide Class "C" co-ordination. Each motor starter control circuit shall be complete with "run" and "trip" indicator lights and a "hand - off - auto" switch. Each duty / standby control circuit shall also be complete with a 1 / 11 duty select switch.

Each burner circuit shall be complete with MCB, contactor, "on" and "boiler lockout" indicator lights and a "hand - off - auto" switch. The burner lockouts and/or common alarms shall be wired as alarm inputs to the boilerhouse MCC panel.

The MCC panel shall monitor and control the operation of the equipment as indicated on Drg No. 59-00.

7.2.1 Remote Control and Indicating Panel

A remote control and indicating panel shall be supplied and installed in the location indicated on the drawing. This panel shall allow full access to set points and time schedules for each heating circuit/zone. (Refer to Control Strategy below)

7.2.2 Compensated Circuits

Variable temperature radiator circuits shall be modulated in response to external temperatures by modulating the output from the boiler(s). Internal room sensors shall hold the motorised pressure independent control valve (PICV) motorised valves in the fully open position until the space temperature is attained.

The internal sensors shall be adjustable to +/- 3°C of the setpoint temperature.

7.2.3 Control Strategy

The controls shall allow independent time (7 days/24 hours) and temperature control of each radiator circuit.

A remote monitoring and control panel indicating the status operation and overriding facilities shall be provided in the Administration Office or location indicated on the drawing. This shall include a manual override with a selective switch of up to 3 hour run on timer so that heating zones are available for occasional out of hours use. The unit shall be of a type appropriate for its location in terms of aesthetics and size. Industrial housing shall not be acceptable.

The heating systems shall be such as to maintain a minimum even temperature of 18° degrees in all teaching and habitable rooms.

Holiday switching shall be provided on the boilerhouse control panel to override time schedules while maintaining frost protection.

7.2.4 Boiler Frost Protection Controls

Frost protection shall be installed in order to protect the system in the event of low outside temperatures during boiler off periods. The frost protection system shall override the boiler timeclock and activate the circulating pumps in the event of the outside air temperature dropping below 3°C. This shall be controlled by an external frost – stat located on the north facade of the boiler house.

An adjustable immersion thermostat shall also be fitted to the boiler return line and shall activate the boiler and circulating pumps in the event of the return water temperature dropping below 5°C.

7.2.5 Pressurisation Unit

The pressurisation unit shall be linked to the control panel and the supplier shall ensure that volt free contacts from the unit are made available to provide indication of system high or low pressure. Upon high pressure alarm the boiler shall be disabled.

7.2.6 Plant Override

An auto override switch shall be fitted on the panel fascia to allow the heating circuits to be overridden on. In the override position the boiler shall start, heating circuit pump shall start and associated mixing valve shall drive full open.

Under override operation no temperature control shall be provided by the modulating control valves. Full heating flow shall be provided.

7.2.7 Control Specialist

The Control Specialist shall be a sub-contractor of the Contractor and shall be responsible for the design, supply and installation of the control panel and associated field wiring and containment. It shall be the Control Specialist's responsibility to provide all power and control wiring from the control panels.

The controls specialist shall be responsible for preparing detailed schematic drawings outlining his proposals to meet these requirements.

The specialist shall be responsible for giving a full demonstration on the operation of the system to the staff.

7.3 Energy Monitoring & Targeting

The BMS system shall also provide monitoring and targeting of the building's mains water, electricity use. New meters shall be installed on the mains water supply, main incoming electricity supply in the future. They are not part of this contract. The meters shall be wired back to the MCC panel or remote outstation. The monitoring and targeting system shall be based on an easy-to-use open licenced software which shall display real-time use and record up to 36 months' data.

7.3.1 System Requirements

A simple target and monitoring system based on a traffic light format shall be installed in schools to inform relevant personnel in a school, in a quick and understandable manner, how the school's Energy and Utility Supplies are behaving, when set against targeted parameters. This information can be available on the Principal's PC on start-up and shall also be capable of remote monitoring and alarm via a Global System Mobile Communication system (GSM) to let required personnel know of the problem.

For example:

- If the light is Green, all is fine
- If the light is Amber, there is a problem, but not very serious and can be dealt with accordingly
- If the light is Red immediate action must be taken.

The following parameters will be measured:

- Electricity
- Heating fuels
- Mains water to the school (meter located in boiler room)

This system shall be applied to a whole school, i.e. one electrical meter and one water meter.

The Contractor shall liaise with the school authorities prior to commissioning of the T&M System and set the desired levels of electricity, water and fuel usage taking into account seasonal adjustments.

The traffic light system shall operate as outlined below and inform the school management if action is required and operates as outlined below:

Green:

The electricity, water and fuel usage are within the required bands.

ACTION REQUIRED:

None; all is well.

Amber:

Typical Amber situations would occur if a meter indicates that a utility was being delivered for longer than required but then shuts off.

ACTION REQUIRED:

The school management shall investigate within a day or so.

Red:

Typical Red situations would occur where meters are registering energy usage yet the building is not in use.

ACTION REQUIRED:

The school management shall investigate immediately.

7.3.2 Target and Monitoring System

The T&M System shall be an open source computer-based monitoring system for mechanical and electrical services with a standard P.C. used as the customer interface to the system.

The system shall be supplied with a complete PC package including monitor and keyboard. The PC shall have, processor (highest speed available), CD Rom drive, 4 No. USE drives, 1 TB hard disk, 4GB RAM, monitor, keyboard, mouse etc.

The P.C. shall be connected by a ring cable loop to all the field outstations to which all meters shall be connected. The P.C. shall have graphical screens of the building layout and of all meters being monitored.

The Controls Specialist shall allow for creating and programming into the T&M system schematic colour graphic diagrams of the plant, generally in accordance with the plant installed.

7.3.3 Outstations

All outstation equipment shall be manufactured by the Controls Specialist utilising their latest advanced range of Direct Digital Controllers. The outstations shall consist of all necessary hardware and software to provide a totally Stand Alone and intelligent unit capable of all monitoring, corrective action, and control functions as required.

Each intelligent outstation shall control its local plant independently of the control of any central BEMS workstation. The Outstations shall continue to operate fully in the event of a possible total failure of the BEMS workstation or any other outstations. The outstations shall be microprocessor based, multi-tasking, direct digital control units.

A local operator's keypad display panel shall be housed on the fascia of each control panel for local command entry, instantaneous data display, program additions and modifications. With the use of a fascia keypad the operators display panel shall allow the user to address parameters and status of plant, change time clock settings and modify all set points using simple English text.

All possibility of unauthorised adjustment shall be eliminated either by physical means or by the use of a password system.

The outstation shall incorporate a power supply unit to preserve existing software and data for a period of 30 days upon loss of power to the outstation. The batteries having a minimum life span of three years. Upon restoration of normal power the outstation shall automatically resume full operation without any manual intervention whatsoever. All default values shall automatically reset following restoration of power supplies and the central BEMS workstation shall be updated automatically with the working values.

Each "Stand Alone" Outstation shall consist of modular hardware with plug-in enclosed processors, power supplies and input/output modules. A sufficient number of controllers shall be provided to fully meet the requirements of this specification. All Outstations shall have a self-analysis checking feature and shall transmit all malfunction messages to the central BEMS workstation.

The outstation shall be suitable for programming locally at the plant room and centrally from the BEMS workstation.

All outstation equipment shall operate satisfactorily in the electrical environment and ambient temperatures experienced within plant rooms or boiler house areas. All equipment shall be protected against the effects of conduction, heat transfer and radiated mechanical/electrical interference.

Outstations shall provide serial data communication ports for simultaneous operation of multiple operator devices such as industry standard printers, Laptop workstations, PC workstations and panel mounted or portable operator terminals.

Outstations shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

Outstations shall provide visual (LED) local status indication for each binary input and output for verification of all point conditions without the need for an operator device.

As a minimum requirement, each outstation shall support the following types of inputs and outputs.

- Digital inputs for status/alarm monitoring.
- Digital outputs for On/Off equipment control.
- Pulsed inputs for energy monitoring of utility meters, electricity and water etc.

- Universal input/output points up to 20 configurable channels.

The system shall be modular in nature and shall permit easy expansion through the software application, workstation hardware, field controllers, sensors and actuators.

Each outstation shall be provided with 25% spare hardware points and printed circuit boards for each type of input/output points for future installations.

Suitable voltage filters, surge protectors and stabilizers shall be provided at all outstations as well as field point terminations to suppress induced voltage transients surges and fluctuations, consistent with the LEE and current British Standards. The devices shall ensure the outstation continues to function successfully at all times.

7.3.4 Electricity Meters

Electricity kWhr meters shall be provided in the main switchboard to allow monitoring of energy use. The electricity meter shall be supplied and installed by the panel manufacturer.

The Controls Specialist shall be responsible for the correct sizing and selection of all meters and equipment in accordance with the currents, voltages, flow rates, line pressures, and sizes as indicated in the Specification.

7.3.5 Display Centre

In addition to the information being displayed on the Principal's PC it shall also be capable of being displayed through the ICT structure to the teaching spaces.

The display shall show graphs of hourly usage of Electricity, Water and Fuel set against desired targets.

7.3.6 **Energy Target Review**

The commissioning engineers along the Engineer shall return to the school following a full year of operation of the system and in conjunction with the controls company and contractor reassess the targets set and confirm that they are correct and match the school's energy usage profile. If they don't remedial action shall be undertaken to ensure proper targets are being met and that the system operates correctly.

Where necessary any measurements and remedial adjustments shall be applied.

This must be completed prior to release of final retention.

8 **ELECTRICAL INSTALLATION**

8.1 **General**

The Mechanical Contractor shall include for employing a qualified and competent Electrical Contractor to carry out all electrical works associated with this contract.

The Electrical Contractor shall include for the complete wiring of all LV and ELV wiring associated with the mechanical services installation.

The Mechanical Contractor shall provide wiring specifications and diagram to the Electrical Contractor prior to commencing first fix works. The specification shall include a list of all items of mechanical equipment, including pumps, motorised valves, thermostats and other control equipment, etc. to be wired by the Electrical Contractor. The list shall also include cable sizes and types for each item of equipment.

8.2 **Boiler Plant**

The Electrical Contractor shall include for the following electrical works:

1. Disconnecting and removal of obsolete wiring associated with existing heating system.
2. Supply and installation of submain cable and associated switchgear to serve new boiler house MCC panel.
3. Supply and installation of power and network cables to serve remote monitoring and control panel.
4. Supply and installation of all power and control wiring in boilerhouse serving motorised 3-port valves, pipe thermostats, pumps etc.
5. Supply and installation of wiring to serve radiator zone/room thermostats.
6. Supply and installation of wiring to serve external weather sensors.
7. Supply and installation of fire alarm interface unit to connect to new MCC panel in boilerhouse to shut down heating plant on activation of fire alarm system. Fire alarm system to be re-commissioned as part of works.
8. Supply and installation of local isolators to serve each item of mechanical plant, e.g. pumps, pressurisation unit, unit heaters, etc. These isolators shall be IP 54 TP&N, polycarbonate construction, type 'Safetyswitch' as manufactured by MK Electric Ltd or equal and approved. Wiring to be concealed in surface mounted steel conduit..

8.3 **CE Marking**

All equipment shall show and signify compliance by CE Marking being present in a visible location as defined by the applicable directives.

8.4 **NSAI National Wiring Rules**

The whole of the electrical work shall be carried out in strict accordance with the latest Edition of the ETCI National Wiring Rules for Electrical Installations and any other relevant local, statutory or government authority.

In particular he shall note the specific requirements in relation to the most recent edition of the NSAI Rules (I.S. 10101: 2020) and shall ensure that nothing in this tender document or any subsequent post tender instruction, written or verbal, is in contravention of the requirements of these Wiring Rules. All such matters shall be referred to the engineer in writing for clarification and instruction

8.5 Isolation of Plant and Equipment

Every item of mechanical plant shall be connected by means of a local isolation device. The isolator may be a 20Amp double pole switch for single phase plant up to 3kW.

Pumps and motors which are served by Auto Star Delta (ASD) or multi speed starters shall be controlled by a local multi-pole isolator with auxiliary contact. The auxiliary contact shall break the feed of the control circuit in such a way that the starter, and not local switch disconnects, the load current, i.e. it shall 'break' before and 'make' after the main poles of the isolator.

Each isolator shall be fitted with a white screw fixed triplex label engraved with 6mm high lettering, stating the plant and circuit reference. An identical label shall be fixed to the item of plant.

8.6 Steel Conduit Systems

Steel conduit shall be heavy gauge, welded, hot dipped galvanised (Class 4) steel type with minimum size 20 mm and complying with the relevant B.S. The Contractor shall refer to the ETCI National Rules for the determination of the sizes of conduit necessary to accommodate the various cables.

Conduit boxes and fittings shall be malleable cast iron, galvanised and screwed to receive the conduit. In general fittings with tapped bush spouts with stop ends shall be used. Bushes, glands, plugs etc. shall be brass. Adaptable boxes shall be galvanised sheet steel pattern. Weatherproof gaskets shall be used in external or damp locations.

Screwed flanged couplings shall be used in all surface conduit installations for connection of conduits to outlets boxes, miscellaneous switchgear items, trunking outlets etc., Screwed flanged couplings shall be fixed complete with male brass bushes and compression washers shall be used. Normal couplings will not be acceptable in these circumstances.

Sufficient draw-in boxes shall be provided to ensure the cables shall be easily drawn into position. The number of cables installed in a conduit shall be such that cables can be easily withdrawn without causing damage to the other cables. In any event the number of cables shall not exceed 75% of the amount allowed in the ETCI National Rules. Conduit runs shall not exceed 10 m in length or have more than 2 right angle bends in without the provision of a draw-in box unless approved by the Engineers. Expansion couplings shall be installed where necessary at structural expansion joints.

All bends as far as possible shall be made from conduit. Inspection elbows and tees shall not be used in installations, except for sizes greater than 32 mm diameter. All joints in conduit shall be made by screwed couplings with locknuts on running couplings. Suitable condensation drainage outlets shall be provided wherever necessary.

Threading and de-burring, etc., shall be carried out in an approved manner consistent with good practice and workmanship. All cut threads, etc., where the galvanising has been removed, shall be coated immediately with suitable rust proofing paint and all joints shall be coated again after erection. Threading of conduits shall be carried out using a proprietary threading paste.

8.7 Earthing & Bonding

Main bonding conductors shall be installed between the earthing bar in main switchboards and each of the following;

- Water Mains (Metal) - 25mm²

- Motor Control Centre - 16mm²

Main bonding conductors shall connect the extraneous conductive parts of the main engineering services, such as water and central heating pipework to the main earthing terminal.

The connection of a main bonding conductor to a service pipe shall consist of a suitable strap on clamp with screws that provide tightening of the strap around the pipe. The use of perforated metallic strip for this purpose shall not be acceptable. A permanent label inscribed "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE" shall be permanently affixed at the main bonding connection to each main engineering service.

8.7.1 **Supplementary Bonding Conductors**

Supplementary equipotential bonding conductors shall interconnect the protective conductor, all extraneous conductive parts and all exposed conductive parts including socket outlet earthing contacts in a given location.

Supplementary bonding conductors shall consist of insulated stranded copper conductors with a cross sectional area in accordance with (a) or (b) below, but not less than 2.5 mm².

A supplementary equipotential bonding conductor connecting two exposed conductive parts shall have a cross sectional area not less than that of the smaller protective conductor connected to the exposed conductive parts.

A supplementary equipotential bonding conductor connecting exposed conductive parts to extraneous conductive parts shall have a cross sectional area not less than half the cross sectional area of the corresponding protective conductor.

The connection of a supplementary bonding conductor to a service pipe shall consist of a suitable strap on clamp with screws that provide tightening of the strap around the pipe. The use of perforated metal strip for this purpose shall not be acceptable. A permanent label inscribed "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE" shall be permanently affixed at the supplementary bonding connection to each service pipe.

9 SUPPORT FOR PLANT AND EQUIPMENT

9.1 Introduction

The Contractor shall include for the supply and installation of supports for all piped services, plant and equipment throughout the entire installation.

10 **BUILDER'S WORK**

10.1 **General**

The Contractor shall employ a competent and experienced builder and/or other relevant trades companies to carry out all builder's works associated with this project.

The following is a non-exhausted list of builder's works:

- Covering over all IT equipment (smartboards, PCs and printers), furniture, shelving, etc. in all areas with clear light gauge (1,000 / Grade A) polythene, prior to any works commencing to protect from dust and debris.
- Forming holes, slots and recesses in the building fabric and making good finishes.
- Re-painting walls, ceilings and/or woodwork damaged during works.
- Trenching, backfilling and making good ground finishes for installation of external pipework
- Installation of new concrete plinth for heat pump.
- Filling in opes left in floors, walls and ceiling left with the removal of existing services and painting in to match existing wall/ceiling background paint colour.
- Painting all new exposed pipework to match existing wall/ceiling background paint colour.
- Painting all new exposed steel conduits and trunkings to match existing wall/ceiling background paint colour.
- Employ a professional cleaning company to carry out a deep clean of the entire school on completion of the works. This shall include but not limited to:
 - Removal of all rubbish and contractor's materials
 - Dusting down of all surfaces
 - Glass cleaning on all internal and external glazed elements
 - Cleaning down window blinds
 - Hovering, moping and polishing hard floors
 - Hovering all carpet areas.

The Contractor shall allow 3-4 days for the deep clean which shall be completed prior to the handover date. The entire building shall be left ready for occupancy.

11 **LABELLING OF SERVICES**

The Contractor shall include for providing identification and labelling of all new mechanical and electrical services as described below.

11.1 **Mechanical Services Labelling**

The Contractor shall be responsible for assigning identification references to valves, plant and equipment, individual circuit control devices, etc. in accordance with the numbering/referencing system used in the record documentation.

Sample identification labels shall be submitted to the Engineer for approval.

Care shall be taken to ensure that the label material is suitable for the temperature of the surface to which it is to be attached.

11.1.1 **Pipework Identification**

Unless otherwise indicated, all distribution services shall be colour coded and provided with symbols for identification purposes. Identification coding for pipework, including thermal insulation, the basic colour and colour coding shall be in accordance with BS 1710.

Proprietary PVC identification bands or triangles shall be securely fitted to pipework throughout the building. These shall identify the service and shall be fitted in the following locations unless otherwise indicated: -

- Both sides of each valve
- At each change in direction
- On all horizontal run at a minimum of 4m intervals.
- Both sides of any wall or partition through which the pipe passes.

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

- Hot water service HWS
- Hot water return HWR

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

11.1.2 **Plant Identification**

The Contractor shall supply and install identification labels for all items of plant and equipment. The label shall indicate the item of plant and its reference number which shall be consistent with all record documentation.

Identification labels shall be engraved traffolite with black printing in capital letters, 8 mm high on a white background. Labels shall be securely fixed, in a visible position, to the item of plant. Labels shall be mechanically fixed; adhesive fixing will not be accepted.

11.1.3 Valve Identification

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

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

The Contractor shall be responsible for assigning identification references to valves, plant and equipment, individual circuit control devices, etc. in accordance with the numbering/referencing system used in the record documentation.

11.2 Electrical Services Labelling

The Contractor shall include for all equipment to be clearly and permanently labelled, to the satisfaction of the Engineer.

Where labels are provided for making clear the method of operation of apparatus they shall be concise and preferably diagrammatic in form. Labels on plant items shall be of corrosion resistant material and engraved with full details of the duty, electrical characteristics, weights and manufacturers serial number.

11.2.1 Labelling of Switchgear

Each distribution board shall be fitted internally with a TYPED list giving details of all MCB or fuse ratings, supply phase, equipment served and size and type of circuit conductors. Each list shall be mounted in a robust clear plastic envelope suitably and securely fixed inside. An additional copy of each circuit chart shall be incorporated in the maintenance manuals.

11.2.2 Labelling of Local Isolators and Connection Units

A local isolator as specified elsewhere shall serve each item of mechanical plant such as fans, pumps, condensers, water heaters, boilers, chillers etc. Each isolator shall be fitted with a white screw fixed triplex label engraved with 6mm high lettering, stating the reference. An identical label shall be fixed to the item of mechanical plant.

Each fused connection unit serving Fire and Security Systems shall be labelled using a self-adhesive label stating the circuit reference number and the item of equipment being served e.g. **Door intercom PSU, LEM Station No 12** etc. An identical label shall be fixed to the item being served.

12 **HANDOVER**

12.1 **Introduction**

The Contractor shall include for the hand over and for the instruction of the Employers staff on the operation and maintenance of the various components forming the Mechanical and Electrical Services Installations.

Upon completion of the installations, a certificate in accordance with Appendix A shall be completed to verify that the system has been demonstrated to the users and that instruction manuals have been checked and issued to the School Principal. Each certificate shall be signed and dated by the School Principal and by the Engineer.

12.2 **Pre-Handover Checklist**

The following list details of items shall be submitted or verified in writing by the Contractor prior to Practical Completion and the Engineers attendance on site to witness the installation (where applicable).

The Contractor shall be liable for all costs incurred by the Engineer as a result of the Contractor's failing to action these items:-

- Electrical Installation Test Certificate in accordance with ETCI National Wiring Rules
- Fire Alarm Installation and Commissioning Cert
- Pumps Commissioning Certs
- PICV Commissioning Cert
- Heating System Commissioning Flow Rates
- BMS Commissioning Cert
- "Treatment of Electrical Shock" notices in all plant areas containing electrical equipment

12.3 **Hand-Over Certificates**

Prior to project completion the Contractor shall complete a certificate stating that all tests, commissioning certificates have been completed to the satisfaction of the Employers representative and that installations are complete and safe to operate.

The Engineers shall carry out an inspection and advise the Employers commissioning officer as to the condition of the installation. The Engineers, shall, if required, have tests carried out by the Contractor to demonstrate the performance of any part of the installations.

When installations have been completed to the satisfaction of the Engineers, the hand-over certificate shall be countersigned and the installation shall be deemed to be at Practical Completion stage.

A schedule of all outstanding work and snags shall be attached to this certificate and a programme agreed for its completion.

12.4 **Instruction of Employers Staff**

The Contractor shall include in his tender for the instruction of the Employers staff on the operation and maintenance of the various components forming the installation.

The Contractor shall prepare a full and detailed handover schedules detailing all systems to be demonstrated to the client, the time scale of the handover and demonstration and recommended attendees, etc. All this information shall be submitted in draft to the Engineer and the client for comment.

When nominated suppliers' appointments include for instruction of the Employers staff, the Contractor shall be responsible for ensuring that such instruction is completed satisfactorily. The Contractor shall ensure, before placing an order, that this is made clear to the Specialist Supplier.

The contractor's supervisor and a representative from each specialist supplier shall be present for instruction of the employer's staff for each individual system such as: BMS, Heating, Lighting Controls, etc.

The Contractor shall include for the following demonstration days:

- Caretaker (1 day)
- School Staff (1 day)

12.5 **Demonstration DVD**

A simple DVD recording shall be made of the Contractor's formal handover talks including the training and demonstration of the M&E services and training in their management and use and handed over to the school authorities together with a fully completed and signed Handover & Completion Record Sheet .

13 **OPERATION & MAINTENANCE MANUALS**

The Contractor shall include for provision of operation and maintenance manuals including "as-installed" drawings for issuing to the client upon completion of the works. The term operation maintenance manual shall be deemed to include all necessary maintenance and operating instructions and record drawings for the entire installation.

The maintenance manual shall be issued for approval at least one month in advance of the intended date of practical completion.

The Contractor shall hand over two copies of the manual to the client and shall instruct the client's staff in the operation and maintenance of the various components forming the installation.

The operation and maintenance manual shall comprise one of more A4 lever arch ring binder files, endorsed with the project details and contractors name and address. Transparent cellophane envelopes / polypockets shall be provided to hold copies of the "As-installed" drawings and any other items which cannot be punched. Cardboard dividers shall be provided to separate the various sections of the manual. Each divider shall be neatly labelled.

The operations and maintenance manual shall be split into the following sections: -

- Index
- General description of the installation, equipment used and method of operation of the installation
- Handbooks, maintenance instructions, drawings and spare parts list for all components, plant and equipment used in the contract works
- Schedule of routine maintenance complete with routine grease points and recommended lubricants. Schedule of periodic and preventive maintenance
- Wiring diagrams of plant
- Manufacturer's Service Manuals for all specialised plant
- Schedules of equipment supplied giving names of manufacturers, serials numbers of plant, electrical supply and power rating, etc.
- Outline design data of plant
- Test and performance data
- Commissioning Certificates
- As-installed drawings.

13.1 **'As-installed' Drawings**

Throughout the contract the contractor shall keep on site a complete set of "up-to-date" prints marked up with "As-installed" details. These prints shall be available for use by the Architect or M&E Engineer.

As part of this contract, the contractor is requested to produce two full scale paper prints and a digitised copy presented on a compact disc (CD) of "As-installed" drawings. The digitised drawings shall be completed in the latest version of Autocad.

One paper print of all "As-installed" drawings shall be issued to the Engineer for approval of format and general content prior to the final issue. These prints for approval shall be sent to the Engineer in

sufficient time to allow him 20 days for approving.

The use of Tender drawings shall not be permitted for a preparation/submission of "As-installed" drawings.

Upon completion of the contract, the contractor shall provide two sets of paper prints and a CD, containing the "As-installed" drawings, to the client as part of the overall O & M package.

14 **TESTING AND COMMISSIONING OF SERVICES**

14.1 **Introduction**

The Contractor shall include for testing and commissioning all mechanical and electrical services forming part of the contract works.

All testing and commissioning shall be in accordance with the following applicable codes and standards:

- ETCI Regulations, IS 3217: 2013 standard
- Safety Health and Welfare Regulations
- CIBSE Commissioning Codes A, B, C, W, and R
- BSRIA Application Guide 3/89.1 – The commissioning of Air Systems in Buildings
- BSRIA Application Guide 2/89.1 – The commissioning of Water Systems in Buildings
- BSRAI Application Guide 8/91 – Pre-commission cleaning of water systems.
- Manufacturers Recommendations and Instructions
- HVAC Codes

Prior to the testing and commissioning of the systems all dirt, dust, debris etc. shall be removed from all plant and equipment, which shall be in turn cleaned inside and out. The installation shall be completed to the satisfaction of the Engineers.

Cleaning of systems shall follow recommendations of the relevant CIBSE Commissioning Codes and where indicated chemical cleaning of water systems shall be carried out where specified.

Any items of equipment set to operate at or below the test pressure shall be isolated or removed prior to applying the test.

Where pipework is buried or concealed permanently within the structure, such as trenches sealed ducts or roof spaces, etc. These sections shall be tested in addition to the above test prior to concealment.

The contractor shall ensure that the pipework is installed to the latest standards i.e. adequately supported, that handles or hand wheels, as appropriate, are fitted to all valves, etc.

The Contractor shall demonstrate that the system is fully balanced and that correct flow rates are available at all outlet positions to the Engineer or their representative.

All pressure tests shall be carried out prior to the application of insulation.

All pressure test certificates must be witnessed and signed by the Engineer.

14.2 Pre-Commission Cleaning

Systems shall be flushed with water two to three times initially or until the water is completely clear. All strainers shall be taken out and cleaned after flushing with water. Pre-commission cleaner ChemSperser 105, which is dosed @1% of system volume, shall then be added direct to system. The system water control shall then be circulated for at least 4 and up to 24 hours. The complete system shall then be drained to remove all iron debris and pre-commission cleaning chemicals. This shall be confirmed by reference to system water conductivity.

After draining the systems they shall be thoroughly flushed with fresh water at least twice again until clear. Aqua Chem personnel shall test the system and advise if further flushing is required. The contractor shall spot check a number of strainers and if clean it is not necessary to check all of them. If there is still some debris in them all strainers need to be checked and cleaned.

Once the systems have been thoroughly flushed they shall be immediately dosed with the following inhibitor: ChemHib 201 @ 1% of the volume of the heating system.

Glycol, if required, shall also be added to the chilled system while it is being filled with water and the ChemHib 201 inhibitor shall also be added at this time as well.

The systems shall then be tested to ensure that they have the required level of inhibitors for correct corrosion protection.

Glycol levels shall also be checked using a Refractometer and the level recorded on a commissioning report.

Full Certification shall be provided after each system has been pre-commission cleaned and dosed with correct amount of inhibitor.

14.3 Low Pressure Hot Water Systems

On completion of cleaning of the installation the Contractor shall re-charge the LPHW heating system with clean water and subject it to a hydraulic test of 1.5 times its working pressure and held drop tight for 8 hours.

The Contractor shall submit to the Engineer a documented commissioning report for all low pressure hot water systems containing the following items:

- Volume flow rate of each pumped circuit.
- Resistance of each pumped circuit.
- Running current and overload setting of each pump.