Roger Parker Associates Limited
Electrical and Mechanical Engineering Design

Mechanical and Electrical Engineering Services Performance Specification For

For IWM Lambeth Road, London- Boiler Replacement Project

Part Two
Mechanical Engineering Services

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2.1 General

This specification section, Part Two, details the Mechanical Engineering services for the project described below and shall be read in conjunction with all other sections of this specification:

Part One - General Contract Conditions

2.2 Scope and Sequence of Works

This specification covers the complete mechanical works which is to be priced by the Contractor including the design, supply, delivery, unloading, distribution, positioning, fixing, testing, commissioning and setting work all equipment and materials necessary to form a complete installation.

The works for the mechanical services shall consist of the following:

- Development of the design as described to follow the RIBA "Plan of Work 2013".
- Preparation of design and working drawings including all builderswork requirements for issue and comment.
- Attendance at site meetings.
- Site survey
- Removal of redundant services including oil pipework, redundant calorifiers pipework and pump circuit
- Cleaning and flushing of the **entire** existing heating pipework distribution
- Provision of all necessary attendances and requirements for builderswork
- Modifications as necessary to the incoming gas services
- Modifications to MCW pipework to suit any amendments.
- Installation of new boiler plant and associated flue liner
- Installation of new primary heating circuit and connection back to existing secondary circuits.
- Installation of all associated pipework, valves, controls etc to provide a fully operational low temperature hot water heating installation.
- Modification to boiler room above ground drainage installation to suit
- Boiler room combustion air
- Acoustics and vibration control
- Modification to the existing automatic controls
- Thermal insulation
- Pre-commissioning, cleaning, flushing, testing and commissioning.
- Setting to work all systems including full client instruction on all systems.
- Provision of record drawings and operating and maintenance manuals.
- Electronic operation and maintenance manual
- Provision of 12 months' defects liability period

2.3 Existing Utilities

Gas

The boiler room is provided with existing gas boosters and there is no intention to increase the incoming gas supply.

The Contractor shall survey the existing installation and modify the gas pipework to suit the installation of the new boilers. Additional boiler capacity is proposed and the gas system shall be capable of all boilers firing together.

Mains Cold Water
Mains cold water serves a number of existing pressurisation units; the Contractor shall establish if these are suitable for re-use. Mains cold water shall be extended and modified to suit any revised location or re-positioning.

2.4 Design Environmental Conditions, Equipment Environmental Protection

The Mechanical Contractor shall be the Lead designer for co-ordination of services and shall be responsible for producing co-ordinated lay-out drawings in conjunction with the electrical and all specialist contractors.

2.4.1 Published Design Data

2.4.1.1 General

Generally the CIBSE Guides and IEE Regulations and B.S. codes provide the accepted source for technical data to be used for calculations and design. Only up-to-date versions of the data shall be used.

2.4.2 Diversity Factors

Only apply diversities which are set out in the CIBSE Guide which may reduce heating or cooling. Any proposed design diversities shall be recorded and agreed with the Engineer.

2.4.3 Intermittent Heating - Heating Plant Design Safety Margins

Provide sufficient design safety margins in the heating plant calculations for intermittent heating. See CIBSE Guide A 2015 section 5.10.3.3 - Allowance for Intermittent Heating.

2.4.4 Boiler Selection

The Client has elected to replace the existing four 600 kW boilers with a new modular boiler arrangement as Hamworthy Wessex ModuMax Mk3 4NO. 254/762 V, with three boiler modules stacked vertically providing 12 modules and a total heat output of 2877.6kW, (3300kW gross) based on a 20 degree C differential temperature.

The Contractor may offer alternatives for consideration but must price this option in the summary of tender.

2.4.5 Fluid Flow Sizing

2.4.5.1 Systems Thermal Gains and Losses

Initially make a sensible estimate of network heat losses/gains and then check the estimate when the system dimensions have been established.

1. Heating liquid pipe network. Do not allow less than 10% gain or loss to the pipework systems unless detailed calculations have been carried out.

2. Heating/cooling air duct network. Do not allow less than 5% of the conveyed load to offset heat gain, or losses to/from ductwork systems unless detailed calculation have been carried out.

3. Do not allow less than +5% to fan volume duties to offset leakage from the system unless detailed calculations have been carried out. Consider the implications of leakage from/to builders work ducts and large rectangular ducts. When using builders work ducts beware of:

   - Heat gain/loss.
   - Surface friction factors.
   - Condensation difficulties.
   - Air leakage.

4. Allow for the energy losses and gains related to fans and motors etc.

2.4.5.2 Resistances and Pressure

Do not assume that the drawing board design will represent installed fluid networks. Allow for bends and fittings and other components that may not be shown on the drawings.

Do not underestimate /K' factors, particularly for air flow networks. Fittings close to one another cause increases in 'K' factors. Make the proper allowance for regulating devices. Take filter resistance values for dirty filters and provide means within the system to compensate for the varying flow rates. CIBSE data is not always adequate. More comprehensive data is given in the ASHRAE and Sheet Metal and Air Conditioning Contractors National Association (SMACNA) (American) Guides. It must be noted that acoustic silencer manufacturers will provide data for 'K' factors for silencers near other fittings which can be two to three times more than if the silencer is installed in straight ductwork.

On completion add 15% to the resistance calculations to allow for site installation variations and other unforeseen factors.

Make sure that all sub-branches and main branches off main supply and extract ducts are provided with suitable manual or automatic volume controls.

Commissioning is made much easier if the following design principles are used:

- Reverse return pipework
- Ductwork is sized using static regain techniques.

Note that the equipment configuration should naturally suit the use of a reverse return system, it is seldom worthwhile to run a 'third, pipe.

Where terminal units in both liquid and air networks can only work within certain pressure limits i.e thermostatic radiator valves, VAV boxes, induction units etc. ensure that means of achieving adequate pressure control throughout the network is incorporated in the design. For VAV systems in particular this may need automatic pressure regulators to be provided throughout the system.
Do not rely upon the controls manufacturer to achieve this requirement.

2.4.5.3 Density and Specific Heat

Consider the density and specific heat of the air or liquid appropriate to the system being designed.

2.4.6 System Design and Automatic Control

Plant must be operated and controlled to provide the required outputs under actual operating conditions, as compared with their maximum design capability. Systems and controls must be designed to achieve these results across the full operating range of the systems.

2.4.7 Noise Guidelines

2.4.7.1 Design Guide Lines

Assume manufacturers' data is optimistic and unverified. ALWAYS specify the performance that the equipment must achieve even if a manufacturer and model number is provided.

Assume final measured noise levels will be at least 5db above prediction and hence always choose manufacturers equipment with NR levels 5db below those actually required, to be on the safe side.

Use centrifugal fans where possible.

Where feasible do not choose 2800 rpm/46 rev/s motors, fans or pumps.

Specify regulating equipment that is quiet. This means a maximum p.d. through valves of 1 bar. where possible select iris/radial dampers of the flat type in air flow systems.

Where practical try to achieve symmetry in ductwork layouts serving grilles and if possible achieve self- balancing minimising the need for secondary silencers and high pressure drops across dampers.

As a general design guide the following maximum duct velocities should not be exceeded.

NR design level	Main ducts	Branch ducts	Final Run Outs
20	3.5m/s	2.0m/s	1.0m/s
25	4.5m/s	2.5m/s	1.2m/s
30	5.5m/s	3.0m/s	1.5m/s
35	6.0m/s	4.0m/s	2.0m/s
40	7.0m/s	5.0m/s	2.5m/s

2.4.7.2 External Noise

Noise produced external to the building must not cause the NR ratings stated in the Particular Specification for internal areas to be exceeded. In addition all external noise assessments and details of externally located equipment must be submitted to and approved by the local Environmental Health Department.

2.4.8 Equipment Selection

All mechanical plant should be power factor corrected by the manufacture/ at manufacturer to 0.95 or better.

2.4.8.1 Fans

All centrifugal fans should, where possible, have backward curved impellers so the pressure/volume curve is stable. The pressure/volume relationship is predictable for most backward curved impellors.

The "no flow" pressure (i.e. closed damper) must be at least 20% greater than the duty point.

When calculating motor and electrical power requirements do not allow higher efficiencies than:

- Fan efficiency 75%.
- Motor efficiency EFF1
- Belt drive efficiency 95%.

Unless detailed information is available.

- Allow + 40% on calculated motor sizes up to 7.5kW.
- Allow + 25% on calculated motor sizes larger than 7.5kW.
- If there is a requirement to extend the system at a later stage the increase in power requirements would be additional to the above.

Provide curves with the duty points marked for the actual fans to be installed to allow the Engineer to check that the fan selection is reasonable.

2.4.8.2 Pumps - Belt Driven

The no-flow head (i.e. closed valve) must be at least 20% greater than the duty point.

When, calculating motor and electrical power requirements do not allow higher efficiencies than:

- Pump efficiency 60%.
- Motor efficiency 70%.
- Belt drive efficiency 95%.

Unless detailed information is available.

- Allow + 40% on calculated motor sizes upto 7.SkW.
- Allow + 25% on calculated motor sizes larger than 7.SkW.
- If there is a requirement to extend the system at a later stage the increase in power requirement would be additional to the above.

2.4.8.3 Pumps - Direct Driven

The no-flow head (i.e. closed valve) must be at least 20% greater than the duty point.

Pump cases should be manufactured to enable an impeller capable of achieving an increase in flow of 15% above the specified flow rate to be accommodated. The increase inflow rate would be against the corresponding increase in system resistance. Motors would be sized as described in clause 2.4.8.2

Pumps must be supplied with an impeller selected to meet the specified selection duty.

Pump should be of the non-overloading type.

2.4.8.4 Water Pipework - Circulating Systems

Pipes carrying heating and cooling fluids are to be dimensioned generally at, 200/250 N/m² per metre run of pipe to avoid noise and high velocities. Valve and other components must be pipeline size with the exception of regulating, orifice and control valves which must be selected to ensure correct authority. In many instances equipment connections sizes can have pressure drops significantly higher than 350 N/m². The pipe size reduction should be made at the final equipment connection point.

2.4.8.5 Domestic Hot and Cold Water Services Pipework

Pipes are to be dimensioned to provide the required flow at the outlet from the head/pressure available. Beware of mixed system materials and check the components and systems used with the local water authority.

2.4.8.6 Fouling Factors for Heat Exchange Equipment

Add allowances to cover for the drop in output likely between servicing, i.e. dirty finned coils, partially blocked induction unit jets, dirty filters etc. Specify the appropriate fouling factors as they are critical to the satisfactory selection of water heat exchangers. A fouling factor of 0.088m²C/kW is commonly used for refrigerant/water shell and tube heat exchangers.

2.4.9 System and Equipment Commissioning Data

2.4.9.1 General

The performance data required for equipment selection is different from the commissioning data due to the incorporation of design safety margins. To avoid confusion both sets of data must be clearly specified; this is particularly important for pumps and fans.

Commissioning data should be shown on schematics, and schedules etc., to minimise work in the later stages of the Contract when the information is required by the Commissioning Engineer.

When checking air flows during commissioning allow for dirty filters.

2.4.10 Calculations

Records and Documentation
Properly document all calculations (Preferably on discs)

2.4.11 Equipment Suitability for Environment

All equipment plant and materials located, for example in unheated, partially heated or external locations must be either inherently protected against damage due to its environment (eg by suitable IP rating) or provided by the contractor with additional protection by means of enclosures weather-proofing etc. The contractor shall not install any equipment etc in unsuitable environment and shall seek advice from the engineer prior to installation of any specified item which is considered unsuitable in its environment

All external pipework, ductwork, fittings etc, including all underground services, shall be suitably insulated and waterproofed.

2.5 Description of Mechanical Services

2.5.1 Contractor's Design Elements

The documents include specified mechanical services components required to provide the design performance of the overall system. Clause 1.6 of Part 1 – General Conditions describes the requirement relating to the Contractor's responsibility to develop the design and fully detail the works such that the working drawings are fully coordinated with all other elements. All stage of the design development including calculations, working drawings and technical submittaals of proposed equipment are to be submitted and approved by the Contract Administrator.

All equipment however is designed by it's manufacturer and it is therefore the manufacturer's responsibility to provide equipment that performs in accordance with the published data. The Contractor must therefore accept this same responsibility as part of the contract. Any equipment that fails to provide its published performance or meet the appropriate British Standard shall therefore be repaired or replaced at the Contractor's cost as part of the equipment warranty.

Prior to manufacture of equipment the Contractor shall provide a full technical submission for client approval, detailing the manufacturer's physical, acoustic and all relevant engineering data.

2.5.2 Survey and Removal of Existing

The Contractor shall survey the existing boiler room, clarify all the existing heating circuits and secondary pump flow rates and pressure drops for replacement.

The extent of services removal is highlighted on record drawings and schematics but the Contractor shall establish from site survey the positions within the boiler room where existing circuits are to be stripped back to with an IWM representative. The design intent is to utilise the existing external vertical boiler flue with a liner suitable for condensing boilers. If alternative boiler options are provided the Contractor shall include all works necessary to the boiler flue system

The Contractor should note that existing gate valves are to be replaced with new butterfly valves; existing valves should be assumed as not capable of "holding". Redundant oil pipework and existing redundant circuits such as the calorifer pump circuit shall be removed back to the point of entry into the boiler room and clearly labelled as 'redundant service'.

The Contractor should note the existing hydraulic arrangement and low operational temperature diffierential.

Attention is drawn to the requirements for pre-cleaning and flushing of the entire existing heating system, the contractor should provide a method statement for this activity, note existing redundant circuit pumps may be used for this activity but the heating system shall not be left drained down or empty for any significant time periods.

2.5.3 Heating

The works entails the following items:

- Replacement of the existing boilers generating low temperature hot water (LTHW).
- Modifications as necessary to the gas pipework to suit the new layout
- Replacement of internal boiler flue system, retaining the existing external flue with a grade 316 stainless steel liner
- Replacement of boiler primary circuit and pipework headers
- Replacement of secondary circuit pumps and headers as noted
- New system control valves
- Provision of new plate heat exchanger's providing hydraulic separation between primary and secondary systems (as existing- original primary selection based on only a 6 ^{o}C ΔT)
- Provision of pressurisation equipment and expansion for primary and secondary circuits as necessary
- Provision of new/existing air and dirt separators and strainers.

2.5.4 Hot and Cold Water Services (Domestic Water)

The scope of works allows the following:

- Mains water modifications as necessary to serve pressurisation equipment

2.5.5 Above Ground Drainage

The scope of works allows the following:

- Any modifications necessary to allow for safety valve discharges or overflows

2.5.6 Boiler Room Combustion Air Requirement

The Contractor shall survey the existing boiler room combustion air requirements to confirm compliance with the British Standards and include any necessary changes.

2.5.7 Automatic Controls

The contractor shall supply and install all controls necessary for a fully functioning system. The clients control specialist "SYSCOM" shall carry out this work and modify the headend graphics as necessary.

The system shall be installed in accordance with section 2.16 of the specification and is to be designed, supplied, installed and commissioned by the contractor's appointed BMS specialist.

Containment shall be provided and co-ordinated by the contractor.

2.5.8 Commissionability Report

The Contractor's commissioning engineer shall review the drawings and schematics prior to installation to establish sufficient numbers and locations of flushing, isolation and commissioning valves and volume control damper to ensure the system can be correctly commissioned.

2.5.9 Equipment Warranty and Maintenance

All equipment and workmanship guarantees shall have a warrenty period of twelve months from Practical Completion or final test and acceptance by the Client, whichever is the later.

Twelve months maintenance of the installation is required.

2.6 Utilities

2.6.1 Mains Cold Water

Mains cold water service shall be extended within the existing boiler room to serve final locations or new or existing pressurisation units. The whole installation shall be in accordance with water byelaws.

2.6.2 Metering and Sub Metering

Energy meters and sub meters shall be provided in accordance with Part L of the Building Regulations.

2.7 New Heating Services

2.7.1 Particular Requirements

This project includes the replacement of 4no existing 600 kW boilers with a new modular floor standing low NOx gas fired boiler arrangement such as the Hamworthy Wessex ModuMax mk3. This consists of 4No. 254/762V, three boiler modules stacked vertically providing 12 modules in total with a total heat output of 2877.6kW, (or 3300kW gross) based on a 20 degree C differential temperature.

The Contractor may offer alternatives for consideration but must price this option in the summary of tender.

The Contractor shall design and install a complete new LTHW heating system, comprising of boilers, flue system, plate heat exchanger for hydraulic separation, heating pumps, pipework, pressurisation units and primary/secondary expansion vessels, fittings, gauges, valves, strainers, drain points, air eliminators, expansion devices, painting, anchor points, guides, test points, commissioning valves, dosing pot, sleeves etc. to make a complete installation, as indicated on the drawings and in the specification.

System pressurisation, backflow prevention and system filling may retain existing equipment if deemed suitable.

2.7.2 Standards and Workmanship

The design and installation of the heating services shall comply with:

- CIBSE relevant guides A, B, C.
- Building Regulations Part L
- BS EN 12828:2012 – Heating systems in buildings – Design for water based heating systems.
- BS 6644: 2005 & IGE/UP/10 (ed 2) – Installation of gas fired hot water boilers of rated inputs between 70kW (net) and 1.8 (net). Guidance for installation with inputs in excess of 1.8MW net
- Non Domestic Heating Compliance Guide 2013.

2.7.2.1 Boiler System Hydraulics

Record information indicates that the existing boiler system operates on an unusually low temperature differential of only 5.5 degrees C with a flow temperature of 82^{o}C and a return of 76.5 ^{o}C with two circuits operating on a 60/40^{o}C temperature differential hydraulic separated by plate heat exchangers.

The tender proposal provides a primary boiler circuit operating on a 20 degrees C temperature differential and assumes 80/60^{o}C operating. The contractor shall calculate the final secondary side temperature difference once all circuit flow rates are known.

Two circuits currently operate with existing plate heat exchanger's provides a hydraulic separation from the boiler primary and are therefore provided with independent pressurisation equipment and expansion vessels. The contractor may choose to replace the existing 2No. PHE with new to match revised primary flow rates or alternative remove altogether by introducing mixing valves to reduce the water temperature on the secondary sides. (A mixing valve modulating to a maximum setting at 50%, mixing 80^{o}C water with 40^{o}C return to maintain the set point of 60^{o}C)

Two circuits are weather compensated serving the existing wings and exhibit halls and a final circuit serving the PSA AHU and fan coils. Weather compensated circuits and constant temperature circuits are designed on an 80^{o}C flow temperature and not 82^{o}C with an allowance for a 6^{o}C temperature differential with a return water temperature expected of 74^{o}C. Whilst slightly lower than the existing we do not expect any significant difference. The contractor shall ensure the primary and secondary sides are hydraulically balanced.

The PSA AHU and fan coil circuit is assumed to be a constant temperature and therefore will require a mixing valve arrangement to reduce the temperature differential. The contractor shall establish if this circuit has existing circulating pumps or is served direct from the primary, to ensure hydraulically correct.

2.7.2.2 LTHW Heating Pumps

These pumps are to be twin head in-line, direct coupled centrifugal pumps. Each pump shall be installed as indicated on the system schematic and detailed in the schedules. Motors are to be of the totally enclosed fan-cooled squirrel cage induction type, protected to IP55 enclosure.

Both constant and variable temperature pumps shall operate with inverter drive motors.

The pumps for the radiator circuits are to be calibrated to run under a constant differential pressure, thus slowing when the TRVs close down and similarly when the FCU/AHU PICV valves shuts down. This is achieved via pressure sensor downstream in the pipe.

Pumps with connections of a different size to the main pipework shall be fitted with concentric reducers. Non-return valves shall be fitted to each pump to enable automatic changeover.

Pumps shall comply with the requirements of BS EN 60335-2-51:2003+A1:2008, BS 4082:1969 Parts 1 and 2, as applicable.

Pumps shall be 'type' tested in accordance with the requirements of BS EN ISO 9906:2012 and shall be selected to give the correct fluid flow rate. Unless indicated otherwise, test certificates and performance curves shall be submitted.

Unless otherwise indicated pumps and their drivers shall be segregated such that failure of pump seals shall not result in damage to drive motors.

2.7.2.3 Pressurisation and Expansion

A pressurisation unit shall be provided, together with a separate expansion vessel, as indicated on the drawing. The unit shall be a floor mounted twin pump unit. The mains water is to be complete with a check valve connection to the unit.

The unit shall monitor the inlet water pressure and shut down when the pressure falls below minimum cold fill pressure. When the water pressure is reinstated the unit shall automatically reset. The unit shall show an alarm message to its own display when the system pressure reaches a high or low condition. The alarm signal shall relay back to the control panel and boiler.

The Contractor shall supply and install an expansion vessel together with all necessary interconnecting pipework.

2.7.2.4 Heating Pipework

For pipework specification, refer to Section 2.10.

All heating pipework in the plantroom, ceiling voids, pipework boxings, service risers, externally run etc. shall be insulated.

All high points to be complete with air vents and low points with drain cocks.

2.7.2.5 Pressure and Temperature Indication

Pressure and temperature gauges shall be provided as indicated on the drawings.

Pressure gauges shall be installed on the suction and discharge pipework to each heating and chilled water system.

Temperature gauges of the immersion pocket or strap on type shall be installed on all primary and secondary flow and return pipework and HWS flow and return pipework.

2.7.2.6 Boilers

LTHW gas fired atmospheric floor mounted condensing boilers, fully modulating low Nox shall be installed in the plantroom within the space left by the redundant boilers.

Boilers shall operate at 80^{o}C flow, 60^{o}C return refer to hydraulic section.

All as Hamworthy Wessex ModuMax mk3 254/762V boilers including pipe kit pre- fabricated factory assembled and tested pipe kit for triple stack boilers. The boilers shall be provided with a sequencing controller with two BUS communication modules and external air sensor hard wired.

2.7.2.7 Flue

A new internal twin walled grade 316 stainless steel flue header shall be provided in the main boiler room serving the four triple stacked modular boiler arrangements. The header shall connect into the existing external flue with a flue liner complete with top stub, storm collar, flashing plate and supports. A drain shall be provided from the rear of each stack module and from the base of the vertical external flue.

The existing flue shall be modified by a flue specialist such as Midtherm Hamworthy Flue Systems, the flue specialist shall carry out a full site survey.

2.7.2.8 Gas

The Contractor shall provide a new gas pipework installation to suit the new boiler configuration.
Gas pressure tappings shall be provided on the outlet from the gas meter and the inlet pipework to every gas appliance.

2.7.2.9 Plate Heat Exchanger

A new plate and frame heat exchanger shall be located within the main boiler room to provide a hydraulic separation between the new primary boiler installation and the remaining existing heating circuits as indicated

Plates and connections shall be stainless steel with gaskets manufactured of EPDM. The unit shall be suitable for working pressures up to 10 bar manufactured by Rycroft

2.7.2.10 LTHW Flushing and Cleaning

2.7.2.10.1 Sampling

The Mechanical Contractor shall include for testing as specified below, all sections of all pipework installations.

All labour and equipment required for carrying out the tests shall be provided as part of this Contract.

Cleaning and Chemical Treatment shall comply with the requirements of the statutory authorities and the Health and Safety Regulations.

One month prior to filling/pressure testing a water treatment specialist is to sample the supply water and submit to an independent laboratory for full differential analysis. Tests will include Pseudomonas and nitrite-reducing bacteria (3 week test period). Should unacceptable levels of bacteria be present, further water treatment will be reviewed with the engineer and the client.

Approximately one week before commencing the water treatment process, the Mechanical Contractor is to arrange for a water treatment specialist to sample each system and test for the presence of Pseudomonas (3-day test period).

Three days notice of all tests shall be given to the Engineer to enable him or his authorised Representative to be present.

2.7.2.10.2 Cleaning, Flushing and Chemical Treatment

The extent of the pipework to be chemically cleaned shall be as follows:

- All existing and new LTHW circuits.

Cleaning and Chemical Treatment shall comply with the requirements of the statutory authorities and the Health and Safety Regulations.

A Specialist shall be employed by the Mechanical Contractor to design and implement the pipework chemical treatment process.

Prior to carrying out cleaning or chemical treatment processes the Mechanical Contractor shall ensure that:

- All foreign matter is removed.
- Certified pressure tests have been carried out in the parts of the system to be cleaned.
- Once filled, the pipework installations should not be drained down completely, as their inner surfaces will be prone to accelerated corrosion and bacteriological contamination. Should the period between pressure testing and commencement of dynamic flushing be greater then seven days, then system water is to be inhibited.
- Mains water is to be provided in the plant room with a minimum valved connection size (as detailed in the table below) via a non-return valve. Mains water supply should be adjacent to main circulating. A minimum pressure of 3 Bar should be provided to the highest point of the system:

System Volume (L)	Minimum Main Size (mm)
<2,000	25
2,000 – 10,000	40
>10,000	50

- Circulation has been demonstrated to all parts of the systems and all valves other than those used to isolate sections are fully open.
- All system circulating pumps are to be fully operational throughout the process without interruption.
- No damage can occur to any item of plant or equipment due to cleaning and chemical processes.
- Chemicals used are compatible with system materials.

- All items of plant and equipment subject to damage or blockage due to cleaning and chemical treatment processes are isolated or removed and bypassed.

- All 'dead legs' greater than two metres in length are to be cross connected between the flow and return terminations to ensure adequate circulation of water is maintained during the cleaning process.

- Permanent bypasses are provided as necessary.

- Draincocks are installed coil-side of unit isolation valve to allow backflushing of terminal units to take place.

- All 3- or 4-port valves are live or fixed in the 'open' position.

- Adequate means of access is provided to the pipework systems during the process and continuity of the works. All valves and flushing points must be fully exposed for the duration of cleaning works. This will include the removal of ceiling tiles.

- All foul drains provided shall have been tested and approved adequate. Approval should be sought that the drains are suitable for the chemicals used and any pumping equipment associated with the drainage system is fully commissioned.

- Suitable drainage points are provided with valved 50mm minimum connections, properly sited and installed.

- All automatic and manual air vents are fully commissioned.

- A manual dosing pot is to be installed on the LPHW system as manufactured by Goodwater Ltd (Tel: 0118 973 5003) or equal and approved.

- All requirements of COSHH regulations are complied with during the chemical cleaning and chemical treatment of the system.

The Mechanical Contractor's Specialist shall carry out tests during the progress of the works to ensure that cleaning and chemical treatment processes are operating as required. These test results shall be submitted the Engineer for approval.

2.7.2.10.3 Dynamic Flushing

Flushing and cleaning of the water systems shall be generally in accordance with BSRIA Application Guide 1/2001. The Water Treatment Specialist, such as Goodwater Ltd, shall prepare and submit a method statement for approval prior to commencing flushing.

The Specialist shall use raw mains water for flushing. Permanent system pumps, both run-and-standby, are to be used during this process, which have been commissioned and proven to achieve 110% of design velocity.

The initial velocity flush is carried out to remove solid matter from the system(s) in preparation for chemical cleaning. This is to be achieved by circulating and flushing in sections, as small a section of pipework as possible, using all available flushing points equally. It is the responsibility of the Mechanical Contractor to ensure that the relevant flow rates are achieved. Strainers should be checked and cleaned periodically throughout this exercise.

When all samples drawn from the system are visibly clear and free from solids, the initial flush will be deemed complete.

Chemical cleaning shall commence immediately on completion of flushing or the system shall be filled with the addition of an inhibitor.

2.7.2.10.4 Chemical Cleaning

Upon completion of the flushing process, the Specialist Sub-Contractor shall introduce the chemical cleaning compound into each system and circulate the chemical around the system. Chemicals shall be introduced using the aforementioned chemical dosing pots.

The Cleaning Agent shall be circulated around the system for a minimum period of 48 hours using permanent system pumps.

Preliminary cleaning agent and a degreasing chemical such as Ferrosperse 472 shall be used.

During circulation the Specialist Sub-Contractor shall take samples to determine cleaning progress and flush debris to drain with raw mains water, purge dirt pockets, clean all filters and strainers.

This shall be carried out using the same procedure as adopted during dynamic flushing.

The Mechanical Contractor shall reinstate all equipment isolated/disconnected/bypassed during the cleaning process. The Water Treatment Specialist shall remove sediment within the equipment by flushing and backflushing to drain with fresh clean water. Ensure that the operation of reinstatement is carried out as quickly as possible to prevent re-corrosion of the main pipework system.

When all units are flushed, tests should be carried out on random samples to indicate that water quality is acceptable within the following concentrations from all flushing points:

- Total Dissolved Solids - Equivalent to incoming fresh water.
- pH - Equivalent to incoming fresh water.
- Iron in Solution - Below 5ppm or equivalent to fresh incoming water, whichever is the greater.
- Water Quality - Visually clear, bright and free from suspended solids.

The above reading shall be witnessed by the Engineer for acceptance before signing the completion certificates.

Immediately upon completion of the flushing/cleaning/flushing programme, to the approval of the Client or their representative, Corrotreat 432 (or 422 when aluminium components are present) should be added to the system at a dose rate of ½%. Biocide 515 should be added at a rate of ½L per 1000L to prevent microbiological contamination. Chemicals are as manufactured by Goodwater Ltd (Tel: 0118 973 5003) or equal and approved.

It is also advisable to take a final sample and again submit it to a laboratory to be tested for the presence of Pseudomonas.

2.8 New Hot, Cold and Mains Cold Water Services

2.8.1 Particular Requirements

The scope of works entails the following:

- Extending the new water mains as necessary

2.8.2 Standards and Workmanship

The design and installation of the hot and cold water services shall comply with:

- The current Water Supply (Water Fittings) Regulations
- BS EN 805:2000 – Water Supply – requirements for systems and components outside buildings 2000.
- BS EN 806-1:2000 and BS EN 806-2:2005 (Parts 1 and 2) – Specifications for installations inside buildings conveying water for human consumption.
- Health & Safety Executive "Legionnaires disease – The control of legionella bacteria in water systems". Approved Code of Practice and guidance, 2000. No humidification is specified.

2.8.2.1 Sterilisation

The Contractor shall sterilise all water services installations as detailed below and in accordance with the BS EN 806.

All hot and cold water pipework and the new water storage tank shall be sterilised before the system is brought into use. Before sterilisation, pipework shall be flushed out to remove dirty water, debris, etc. No water shall be used during this flushing operation, nor until sterilisation has been completed. Connection to the mains pipework shall be sterilised first, followed by mains distributing pipes.

The Contractor shall make arrangements with an approved specialist firm to sterilise the drinking water supply pipes by means of portable chlorinating equipment. The Contractor shall pay all charges for all water used for sterilisation and for flushing out.

Cold water distributing pipes shall first be filled with water and thoroughly flushed out. With all draw-off taps closed, and sufficient sterilising chemical added during filling to ensure that, a concentration of 50mg/ litre of chlorine is in solution at the outlet. The sterilising chemical shall be prepared in accordance with manufacturer's instructions. The pipes shall then remain charged for 24 hours, whereupon a test shall be made for residual chlorine. If none is found, the test shall be repeated. Finally, the tank and pipes shall be thoroughly flushed out before any water is used for domestic purposes.

The Contractor shall arrange for samples of each system and each storage tank to be taken, independently analysed and a laboratory analysis report provided. The number and locations for taking samples shall be agreed with the Engineer.

Should these tests prove that the sterilisation process has been unsatisfactory the Contractor shall, at his own expense, re-sterilise the systems and tanks and arrange for further samples to be tested after re-sterilisation. The Engineer may at this time request additional numbers of samples to be taken at no additional cost.

The Contractor shall provide the Engineer with a certificate proving effective sterilisation of the water systems. The Contractor is advised that great importance will be placed upon this certificate being available prior to practical completion.

2.8.2.2 Metering

On entry of the water mains to the building the contractor shall install a pulsed meter which shall be interfaced to the BMS to facilitate monitoring of the water consumption.

2.9 Above Ground Drainage

2.9.1 Particular Requirements

The scope of works comprise of the following elements:

- Overflow or safety valves discharges

Penetrations between fire compartments shall be provided with appropriate fire collars such as the Polypipe "Firebreak" with a 2 hour fire rating or equal and approved.

2.9.2 Standards & Workmanship

The design and installation of the above ground drainage shall comply with:

- Building Regulations Part H
- CIBSE Guide G
- BS EN 12056-2,BS 5955 & BS8000 part 13.

2.10 New Pipework, Valves, Fittings and Supports

2.10.1 Particular Requirements

The Contractor shall provide pipework of the types indicated in the schedules of this specification.

Heating pipework drops and chilled water pipework shall be carried out in heavyweight mild steel tube to BS EN 10255:2004. Joints shall be screwed or welded up to and including 50mm diameter. Pipework above 50mm diameter shall have welded joints. Connections shall be easy sweep long radius bends. Reducers shall be provided to connect different size pipework. Bushes shall not be used.

Hot, cold water down service, cold water main services shall be carried out in copper to BS EN 1057 or Uponor MLCP pipe.

Thin wall tube shall not be used. All joints shall be thoroughly cleaned prior to soldering and wiped clean of flux following soldering.

Compression fittings shall only be permitted at points as directed by the Engineer.

The Contractor shall carry out final connection to all sanitary appliances, equipment, sinks, water heaters and supply to each sanitary appliance, item of equipment, sink etc. a ballofix type isolation valve.

All pipework shall conform to the following:

a) All tubes and fittings shall be of first class quality without defects and complying with the relevant British Standard.
b) Tender drawings are diagrammatic and due allowance shall be made for setting round obstructions. Pipes shall follow the contour of walls, etc. and shall be installed in a neat and workmanlike manner.
c) All pipework shall be fitted so that the pipe surface or lagged surface when applicable is not less than 100mm from the finished floor or ceiling surface and not less than 25mm from the finished wall surface, unless otherwise stated on drawings, or agreed by the Engineer. Minimum clearance between electrical equipment and pipework shall be 150mm for hot water and gas, 50mm for cold water, when these services are run in parallel.
d) Pipework shall be protected before, during and after erection. Pipe ends shall be capped to prevent entry of foreign matter and caps shall be purpose made of plastic or steel.

e) All pipework shall be tested after erection, if necessary in sections to avoid holding-up other trades. No pipework shall be cased-in or lagged before it has been tested. Testing shall be as detailed for the particular service.

f) All pipework, fittings and brazing materials on copper pipework services shall be made of non-dezincifiable material whether specified in particular detail or not. No materials subject to dezincification shall be used.

2.10.2 Standards and Workmanship

2.10.2.1 Joints and Fittings

Joints and fittings shall conform to the following:

a) All mild steel pipework normally exposed to view in rooms and corridors shall have joints as follows: Pipework up to and including 50mm bore shall have screwed joints. Over 50mm shall be welded. Joints shall be made with an approved jointing compound or plastic jointing tape to BS EN 10226-1:2004.

b) All malleable cast iron fittings shall be to BS EN 1256:2006 and be of the banded or beaded pattern.

c) All pipe fittings shall have connections of the size to suit the connecting pipework.

d) Union or flanged couplings as appropriate shall be used where pipework is connected to plant and equipment.

e) Joints shall not be made in the thickness of any wall, floor or ceiling.

f) Pipe fittings shall be installed in such a manner that air or condensate cannot be trapped and pipes can be drained.

g) All joints shall be left clean as the work proceeds.

h) All copper pipework joints shall be light gauge copper to BS EN 1057:2006+A:2010. All capillary fittings shall be to BS EN 1254:1998 with integral solder rings and lead free.

i) Where any new or existing services comprise of more than one type of tube or pipe and another, or where such tubes and pipes connect to differently dimensioned plant, the Contractor shall be responsible for providing and installing the necessary adapters.

2.10.2.2 Pipe Supports

Pipe supports shall be supplied and fixed to the following requirements:

a) Pipe supports shall be arranged at intervals not greater than those shown in the following table.

b) Pipe supports shall be arranged as near as possible to joints and changes in direction and each support must take its due proportion of pipe weight and allow for free movement for expansion and contraction.

c) Vertically rising pipes shall be adequately supported at base or riser to withstand total weight. Branches shall not be used to support the riser.

d) Bracket materials shall be the same as or compatible with the pipework they are supporting. Plastic clips will not be accepted unless specific approval is gained.

Pipe nominal bore (mm)	Intervals for horizontal runs (m)		Intervals for vertical runs (m)	
	Mild steel	Copper	Mild steel	Copper
15	1.8	1.2	2.4	1.8
20	2.4	1.4	3.0	2.1
25	2.4	1.8	3.0	2.4
32	2.7	2.4	3.0	3.0
40	3.0	2.4	3.6	3.0
50	3.0	2.7	3.6	3.0
65	3.7		4.6	
80	3.7		4.6	
100	4.1			

2.10.2.3 Sleeves and Wall Plates

Individual pipe sleeves shall be fitted to all pipes passing through walls, ceilings and floors. The pipe sleeve shall be of the same material finish as the pipe and shall leave a clearance of 1.5mm to 3mm between the pipe and the pipe sleeve and shall be cut to finish flush with the surface of the building fabric.

All sleeves, wall plates, etc. shall allow the pipes to pass freely and allow for expansion.

Pipes passing through sleeves in external walls of buildings, ducts, subways, etc. shall be caulked between pipe and sleeve with an approved material to form an effective and permanent vermin proof and weatherproof seal.

Pipe sleeves through fire barriers shall be caulked between pipe and sleeve with a suitable fire resisting compound and mastic sealed.

2.10.2.4 Pipework Expansion and Contraction

Provision shall be made for movement due to expansion.

Expansion joints or changes in the direction of the pipework shall be correctly aligned to ensure satisfactory operation. Support guides at such expansion joints shall be arranged to ensure that all expansion is taken up at the expansion joint or change in direction of the pipework.

Branch pipes and risers shall be free to move in the correct direction. Where connections are taken to plant and equipment, the connection is to be suitably set to permit movement, with the valve as the fixed point.

Anchors shall be of adequate strength to resist the maximum stress and shall be securely built to the building fabric.

Adequate adjustable guides shall be provided up and downstream of every expansion device. Guides shall be two pipe diameters long, spaced not more that 4 (in the case of 2) and 14 (in the case of 4) pipe diameters from the expansion device or as recommended by the manufacturer.

2.10.2.5 Pipework Painting

All steel pipework to be painted with two coats of red oxide primer prior to being insulated. All un-insulated/exposed pipework shall be left clean and grease fee for final paint and finish by the Contractor.

2.10.2.6 Welding

Where welding is necessary on site, the contractor shall comply with the clients hot works permit system.

Where welded pipework is specified, all preparations, welding rods, fittings, welding and accessories, equipment and tests shall comply in all respects to the relevant British Standard.

The Contractor shall protect the building fabric against scorching and fire damage. Two suitable fire extinguishers shall be provided adjacent to any welding operation.

Unless otherwise indicated steel pipework complying with BS EN 10255:2004 or BS EN 121732:2000 with diameters and wall thicknesses not exceeding DN200 and 20mm respectively shall be welded in accordance with the recommendations in HVCA Code of Practice TR/5, as modified below. Steel pipes of larger diameters and greater thicknesses shall be welded in accordance with BS 2971:1991 or other specifications as indicated or approved by the Engineer.

Joint designs, welding procedures, welder certification and production weld quality shall comply with the requirements as interpreted by the appointed inspection body.

Unless otherwise indicated, joint designs, welding procedures and welder's competency tests shall be as described in HVCA TR/5. Prior approval shall be obtained to the installation of gussetted bends.
Welders shall hold current certificates of competency validated by the appointed inspection body, or similar approved body. Welders without validated current certificates shall undertake the relevant standard tests, witnessed and certified by the appointed inspection body before commencing work. Welders with validated certificates who lack relevant welding work experience in the preceding 3 months, and other welders as directed by the Engineer shall undertake the relevant tests witnessed and certified by the appointed inspection body before commencing work.

Welders shall permanently identify each of their welds with their own marker which will withstand site conditions without damaging system or component performance. Methods of marking shall be approved.

Welds in unconcealed LTHW pipework shall be visually inspected in accordance with the recommendations of BS EN ISO 17637:2011, and copies of the records shall be given to the Engineer. Welds will be checked by the appointed Inspection Body at the time the pipework is pressure tested. Where the appointed is unsatisfied, the welds shall be subjected to the non-destructive testing procedures described below.

Unless otherwise indicated welds in MTHW, and in LTHW pipework which is to be concealed, shall be subjected to a programme of non-destructive testing in accordance with the relevant standard. The method of testing shall be ultrasonic or radiographic in accordance with BS EN ISO 17640:2010 or BS EN ISO 17636-2:2013 respectively, as approved by the Engineer. The testing shall be carried out by certified competent persons recognised by the appointed inspection body. Copies of the test reports

shall be given to the appointed inspection body and the Engineer at times which permit adequate consideration whilst the relevant welds remain exposed.

The NDT programme shall include:

- Testing one of the first five production welds made by each welder
- Testing 10% of the subsequent production welds made by each welder
- In the event of finding a faulty weld, at the discretion of the Engineer, the testing of a further two welds made by the relevant welder

The welds tested in compliance with above shall be as randomly selected by the Engineer.

Welds found to be defective shall be rectified to a standard complying with BS Class II specification to the satisfaction of the appointed inspection body. At the Engineer discretion rectification work shall be carried out by different welders. At the Employer's representative's discretion welders with failure rates considered excessive by the appointed inspection body shall be taken off the works.

2.10.2.7 Pipework Identification

The Contractor shall provide pipework identification to all piped services where routed accessibly and readily visible, ie. in plantrooms, roof voids, ceiling voids, riser shafts, etc.

Identification system shall be in accordance with BS 1710:1984 with colours in accordance with BS 4800:2011.

Individual banks of tape shall be self adhesive, two ply, printed vinyl substrate with a protective polypropylene laminate finish.

In addition to coloured identification bands, the Contractor shall apply direction of flow arrows, abbreviated description of service and flow/return denotation.

Pipework identification shall be applied after insulation/final painting.

The Contractor shall prepare and fix in a location to be agreed with the Engineer a detailed legend in full colour indicating the colour bands and letter codes applied to pipework and a full description of service. The legend shall be suitably framed and covered and mounted in the plant room.

2.10.2.8 Valves

The Contractor is to provide valves as indicated on the drawings and detailed in the schedules of this specification. All valves shall be labelled with brass or Traffolyte labels secured by split ring or proprietary brand of nylon fastener; labels shall indicate size and service and in plant rooms shall be numbered to accord with the plant room valve chart (see elsewhere in this specification).

Fixed orifice and double regulating valves are to be fitted where shown and the Contractor shall allow for accurately setting these valves to give the indicated flow rates on completion. All commissioning valves shall be installed within a minimum of 10 pipe diameters of straight pipe upstream of the metering station and 5 pipe diameters downstream of the double regulation valve. A minimum of 150mm clearance shall be provided around each commissioning station pressure tappings to allow for connection of flow measuring device. All pressure tappings are to be installed vertically pointing up so as not to act as dirt pockets.

Isolating valves shall be of the ball type and provided to enable items of plant and equipment to be removed for servicing or replacement without draining down. Valves to be bronze body threaded to BS EN10226-1:2004 to match pipework. Above 65mm butterfly valves to BS EN 593:2009+A1:2011 to

be used. Butterfly valve construction shall be to provide controlled elastomer compression on flange faces, semi-lugged wafer type design, for installation between flanged pipework connections. Lever operated with long neck body for insulation clearance. Cast iron body, stainless steel shaft, aluminium bronze disc, EDPM seat. All isolating valves shall be provided with a drain cock facility.

Safety and relief valves shall be to BS EN ISO 4126-1:2004 cast iron single or double spring high lift type as appropriate flanged to BS EN 1092-1:2002.

Stop valves shall be bronze or DZR copper alloy body with washer material suitable for the service fluid and operating temperature.

Strainers shall be bronze Y type to BS 1400 with threaded ends to BSEN 10226-1:2004 and screen free area not less than 250 percent of pipe bore. Screen perforations within range 0.7-0.9mm diameter. For 65mm and above to be Y pattern cast iron flanged to BS EN 1092-1:2002, screen perforations to be within 1.5-1.8mm diameter. Internal to external flow through screen - plugged connections for drain, air vent and differential pressure monitoring.

Non-return or check valves shall be used where reversal of flow is to be prevented. For general application the hinged swing flat type valve to BS EN 12288:2010 shall be used for up to 65mm and to BS EN 12334:2001 for 65mm and above, with the light flap pivoting on a spindle or two hangers. The valve shall be fitted with stops to prevent undue movement and shall be quiet in operation. The valve shall be designed and construction to offer minimum resistance in the direction of flow.

Key operated gland cocks with hose unions shall be fitted at all low points of the water systems to ensure that complete drainage make take place. Automatic air vents shall be provided at all high points to ensure complete venting may take place.

Refer to 2.19.1.2 for valve schedule.

2.10.3 Pipework Corrosion

Where copper pipework is specified the contractor shall take appropriate measures to eliminate risks of pin-hole corrosion.

Pinhole corrosion in copper pipework has been an occasional problem, attributed to a number of causes. The principal underlying causes that RPA have researched are listed below, although there may be other causes. There is no attempt to explain the detailed chemistry here:

- Over chlorination
- Flux residues not adequately flushed from the system
- Carbon deposits left during manufacture
- Corrosion caused by bacteria harmful to metals

Phosphate additions to mains water supply provide nutrition for biological growth.Cambridge Water in particular, as a matter of policy, adds phosphate chemicals to water supplies to inhibit contamination of water from lead pipework, which remains extensive in the Cambridge Water infrastructure. The mechanism for this type of corrosion relies on the formation of local bio-film sites in the form of a ‘blister’, protecting the site from dispersal by normal water flows. Bio-films that develop to cause this effect would be created due to:

- Ineffective flushing and chlorination of the new installation
- Stagnant water conditions in the pipework before or since occupation

Once established, the biofilms cannot be removed by normal flow conditions.

These known causes of this type of corrosion are therefore related to material or installation faults and remain the contractors responsibility. Detailed records of the precomissioning, cleaning, flushing and chlorination procedures and results must therefore be submitted at the time of handover.

The contractor shall further guarantee the installation against pin-hole corrosion for 3 years from the date of handover subject to adequate maintenance procedures being carried out by the user as described in the contactor's detailed operating and maintenance manuals. A specific section shall be included in the manual covering this area.

Other instances of premature corrosion of any pipework systems that can be attributed, by independent expert, to material, installation, flushing or commissioning defects in the original installation, shall be treated as latent defects and repaired by the contractor in accordance with the terms and conditions of the main contract, including and consequential damage.

2.11 Mechanical Ventilation

2.12 Chilled Water System

2.13 Heat Pump/Comfort Cooling Installations

2.14 New Ductwork Installations

2.15 Acoustics and Vibration

2.15.1 Particular Requirements

The background noise levels due to mechanical services shall be no greater than the following levels as defined in section 2.4.1.

In addition tonal sounds shall not be audible in any of the above rooms, this is interpreted as there being no one third octave band greater in level than 3 dB higher than both of its neighbouring bands in the range 100 – 8000 Hz.

In order to achieve a level of NR30 in the events room special care needs to be taken in the design and installation of the mechanical services. This document is a preliminary statement of the standards of design that are required in view of the noise levels required.

2.15.2 Vibration

No mechanical or electrical services plant shall exceed the vibration levels appropriate to the rooms listed above.

BS ISO 6472-1:2008 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)" shall be used as the guidance for the maximum vibration amplitudes when measured at the surface of any part of the building structure, as a result of the mechanical or electrical services.

Anti vibration mounts shall be used for all boilers, pumps, lift motors, fans, air handling units, chillers, compressors, motors, pipes, ducts, cable trays and other vibration producing plant as necessary to ensure the noise and vibration criteria are met.

2.15.3 Connections

In general the mechanical and electrical services should be mechanically separated, using resilient mounts, from the structure using appropriate devices to ensure that the minimum of noise and vibration is introduced to the building structure. Special care should be taken at penetrations and service supports.

The mechanical and electrical services may not be directly connected to the steel frame.

2.15.4 Fixings

The fixings used to support the mechanical and electrical services shall all contain an appropriate amount of isolation such that there should be no rigid connection between the mounting of these services and the building structure.

2.15.5 Plant Bases

All plant containing rotating or moving elements shall be mounted on a heavy framework or base supported by anti-vibration mounts or resilient pads, or shall be integral to the plant.

2.15.6 Anti Vibration Mounts

Suitable mounts shall be provided for all fans, compressors, motors, ducts (supported from below), air handling units, heat pumps, transformers, pumps and pipes, (supported from below).

Suitable mounts shall use steel spring or rubber in shear as the isolation mechanism.

Isolators shall be chosen to ensure that the noise and vibration criteria are met, but the isolation efficiency shall not be less than 95%

All isolators shall be adjustable after installation.

The natural frequency of the operational installation, under normal operating conditions, shall be:

- Less than 25% of the forcing frequency
- Less than 50% of the natural frequency of the supporting structure
- Less than 15 Hz

The minimum static deflection shall be:

- Fans 70 mm
- Air handling units 60 mm
- Compressors 75 mm
- Boilers 60 mm
- Pumps 70 mm

All connecting services to plant mounted on anti vibration mounts shall be undistorted by the mounting.

The clearance between the underside of an item of plant and the building structure shall be greater than 100 mm.

The use of two sets of anti vibration mounts on a single item of plant should generally be avoided, but if used they should be chosen to avoid resonant effects.

2.15.7 Duct Hangers

Between the air handling unit and the primary attenuator (or for further if deemed necessary) the ducts should be hung using resilient supports.

Duct hangers shall be of the mixed steel spring/neoprene type.

The minimum static deflection of these hangers, for the design range of conditions, shall not be less than 5 mm.

There should be no rigid connection between the duct and the building structure and the hangers and rods should be vertical.

2.15.8 Pipe Hangers

All pipes shall be resiliently supported from the primary building structure using resilient supports or the neoprene type.

The minimum static deflection of these hangers, for the design range of conditions, shall not be less than 5 mm.

There should be no rigid connection between the pipe and the building structure.

2.15.9 Pipe and Conduit Flexible Connections

Flexible connections shall be used where:

Connection is made to plant items
Noise and vibration criteria will not otherwise be met
Connection is made to isolated structures or components.

They shall be between 100 mm and 300 mm in length.

The pipes separated by a flexible connection shall remain on axis with each other.

The connector shall not be flexed or compressed so as to compromise its isolating performance.

2.15.10 Rubber Pads

If rubber pads are used as vibration isolators they shall have a thickness of greater than 12 mm and achieve a static deflection of greater than 10 mm

2.15.11 Ducts

All ductwork shall be resiliently attached to the building structure.

Ducts should be arranged to ensure a laminar flow of air and thus the minimum of regenerated noise by using gradual bends, gradual changes in cross sectional area and rectangular ducts with low aspect ratios.

Internal spigots should not cause turbulent flow or regenerative noise.

Ducts shall not audibly ring or rattle when subject to full range noise levels of up to 100 dBA.

Room to room sound insulation shall not be compromised by noise transmission through a duct.

The maximum airspeeds shall be as follows:

	Ducts leading to room	Terminal Airspeed
NR30	4	2.5
NR35	6	3
NR40	6	4

2.15.12 Duct Attenuators

Attenuators shall be selected to satisfy the background noise requirements and be manufactured by firms with at least 5 years experience.

Silencer casings shall have wall thicknesses of 22 gauge unless they are cylindrical and with a diameter of greater than 1.25 m.

All seals shall be airtight using low modulus non-setting silicone mastic.

Silencers shall have been tested in accordance with BS EN ISO 7235:2009 “Acoustics. Laboratory measurement procedures for ducted silencers and air-terminal units. Insertion loss, flow noise and total presure loss” and should be supplied with a certificate stating the insertion loss and regenerated noise at the design air velocity.

2.15.13 Use of a Plenum

The use of a plenum shall not reduce the sound insulation between rooms.

Openings into a plenum shall be at least 4 m apart.

2.15.14 Duct Lining

A duct lining may be required to spaces with low noise criteria.

Such lining shall have a minimum sound absorption coefficient as follows

125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
0.1	0.33	0.55	0.84	0.92	0.92

2.15.15 Duct Lagging

To control noise breakout from ducts it may be necessary to apply a lagging material.

Lagging may also be required to control noise breaking into ducts in noisy areas.

Ducts in the plantroom shall be lagged using 50 mm mineral wool with a density of at least 80 kg/m^3 and a surface weight of greater than 15 kg/m^2.

Lagging may be required in other areas to limit crosstalk.

2.15.16 Flexible Duct Connections

Such connections are required where:

- Connection is made to plant items
- Noise and vibration criteria will not otherwise be met
- Connection is made to isolated structures or components.

Such connections shall be between 100 mm and 300 mm in length and shall be imperforate.

All such connectors shall have a surface weight of between 5 and 8 kg/m^2.

All flexible duct connections should be made between ducts that are on axis with one another and should not be stretched or distorted on installation.

2.15.17 Flexible Ductwork

If flexible ductwork is necessary then it shall be of type "Regaduct Acoustic" and have a minimum thickness of 50 mm. The outer casing shall be made of galvanised steel.

2.15.18 Duct Fittings

All fitting shall be chosen to ensure that the background noise criteria and maximum vibration levels are met.

2.15.19 Grilles and Diffusers

No grille or diffuser shall cause audible noise due to air movement or rattling, at the design air speed.

2.15.20 Dampers

The position of dampers shall not generate turbulent flow, especially in rooms where the background noise level is NR30 or below.
Duct design should ensure that the dampers are set as near to their maximum opening position as possible.

2.15.21 Plenum Boxes

These shall be used in order to satisfy the background noise criterion for each room and shall be installed in such a manner that the flow is laminar into and within the boxes. Where indicated on the drawings/schedules the plenum boxes shall be acoustically lined.

2.15.22 Fire Dampers

If fire dampers are required where ducts pass through elements, they shall incorporate a flexible connection on the plant side of the duct.

2.15.23 Regenerated Noise

All attenuators, dampers vanes etc. will disrupt airflow and generate noise within the duct.

Dampers should be as open as possible.

The air speed within the duct shall be chosen to limit regenerated noise.

Terminal elements shall be selected to produce no audible noise due to regenerated noise in any room.

2.15.24 External Breakout

To satisfy planning or other conditions, it may be necessary to install acoustic louvres.

Tonal components of noise breakout increase the effective noise level by 5 dBA.

2.15.25 Service Penetrations

Care is required to ensure that the sound insulation of partitions is not compromised due to service penetrations.

All penetrations shall be sealed appropriately.

Non-setting mastic shall be used to ensure the seal remains flexible for the lifetime of the building.

Isolated elements shall not be bridged by services.

Apertures for penetrations shall not leave a gap of more than 15 mm or less than 10 mm around the duct or pipe.

Any duct lagging shall be removed as it passes through a partition.

Penetrations shall be made good using a material of the same density as the partition.

All gaps shall be fully filled with packed mineral wool, to maintain the isolation of the duct from the structure.

An airtight seal consisting of at least 15 mm depth of sealant shall be used to ensure an airtight seal.

2.15.26 Air Handling Units

If a maximum sound power level for an air handling unit is specified, the figure shall not be exceeded either in its specification or on site.

The air handling unit shall be double skinned as should the duct to the primary attenuator.

2.15.27 Fans

Fans shall be balanced to comply with BS ISO 1940-1 2003.

Fans must be rebalanced after dismantling.

If any parts are replaced the fan shall be rebalanced.

Octave band in duct sound power levels shall be provided for the range 63 to 8000 Hz.

Guarantees shall be obtained that these power levels will not be exceeded on site.

2.16 BMS Controls

2.16.1 Particular Requirements

This section outlines the criteria and standard, which is required for the Building Management System (BMS) package, and should be read in context with the wider tender documentation. This section relates to the design, manufacturer, works testing, supply, delivery to site, installation, site testing, and commissioning of a distributed microprocessor based BMS.

The contractor will be required to provide a control philosophy of the scheme to validate the requirement of the scheme as identified in this specifications. This shall include a full description of operation, BMS points schedule and a MCCP schedule covering all of the building systems and they are to be submitted to the approval of the Engineer priro to developing detailed wiring diagrams for the project.

The provision of control and BMS equipment, control panel, all control devices (valves), actuators, sensors etc plus the necessary configuration, commissioning and testing services shall be the responsibility of the Contractor and the nominated BMS specialist - Syscom.

The contractor, in pricing the works, must use experience of this type of facility to make due allowance in the tender for all material and equipment supply and installation costs arising from the normal design development to final working drawing stages.

Input/ Output schedules are provided for assistance in pricing the project but the contractor shall make all necessary allowances for any additional points during the design devlopment and this is to be refelected in their tender bids any items not included will not be entertained by the Contract Administrator/Client. The controls specialist shall review the schedule provided and ensure all necessary points are included to cover the description of operation proposed.

2.16.2 Electrical Installation

2.16.2.1 Design

The BMS electrical installation is the responsibility of the Contractor and shall include, but not necessarily be limited to, the following:

- The sizing, routing and provision of all conduit and trunking systems to contain BMS power and control cabling.
- The sizing, routing and provision of all BMS cable runs.
- The interfacing and cable termination between HVAC plant and equipment and the BMS.
- The sizing and layout of HVAC control panels and BMS relay panels.
- The selection and sizing of controllers to provide the necessary control outputs
- and monitoring inputs with reasonable spare capacity.
- The positioning of sensors in optimum positions to record true representative conditions.
- The interfacing with electrical control panels and distribution boards.
- The routing of communications cables.
- The sizing of control valves and actuators, motorised dampers and actuators.
- All necessary fire alarm interfaces

The BMS electrical installation work to be carried out by the Contractor shall include, but not necessarily be limited to, the following:

2.16.2.2 Installation Works

- The fixing of controllers and relays and the co-ordination with all other services as necessary to allow for adequate wall and floor space.
- The provision and installation of conduit and trunking runs to contain BMS cabling.
- The provision and installation of BMS cable runs.
- The termination of all BMS cables.
- The provision of the necessary power supplies from BMS control panels to all items of BMS equipment.
- The installation of BMS water immersion temperature sensors into pipework pockets.
- The fixing of outside and room air temperature and humidity sensors.
- The installation of control valves and actuators, motorised dampers and actuators.
- Interface with boiler sequence controller

2.16.3 Operation Strategy

The operation and monitoring of the BMS systems will include the following equipment:-

- Boiler sequencer for cascade control
- LTHW Primary and Secondary Heating Pumps.
- LTHW Primary and Secondary Heating Pressurisation Unit’s.
- Plate heat exchangers
- Control Valves for mixing and temperature
- New circuit heat meters.

2.16.3.1 LTHW Heating System

Design Parameters

Boiler Primary water flow/return temperature – $80^{O}/60^{O}C$
Secondary water flow/return temperature – 60/40 or $80/74^{O}C$

Information to be available on the BMS

All inputs and outputs as indicated.
Pressurisation unit- common alarm's.
Pump Status

System Off Mode

Boilers off, Control valves should be closed and all pumps off.

System Start Up

Boiler plant start signal shall be initiated by any one of the following:

- Optimiser
- Heating water demand
- Fresh air heating demand
- Frost condition (second stage)

Boiler plant shall be inhibited by any of the following and shall raise an alarm at the BMS

- Boiler primary pump flow failure (DP switch)
- Pressurisation unit fault
- Pressurisation unit flow warning (leakage)
- Fire condition
- Boiler flow high limit setting
- Boiler integral control lockout

Twelve boiler modules shall be enabled by temperature signals from the manufacturer's modulating sequence cascade controller, this controls boiler modulation, external control enable signals to be volt free or 0-10 volt analogue heat demand input signal.

Monitor each pump for flow status via differential pressure sensors. When flow failure is detected raise an alarm and switch over to standby pump.

Provide differential pressure sensors across the pumps to monitor pump fault.
Rotate the lead pump on a regular basis, based on hours run.
Each pump will run under its own control variable speed control once enabled by the BMS.

Control the flow of LTHW circuits for either weather compensator or constant temperature set point. (by three port control valves).

Monitor water temperature at main flow and return pipes.
Monitor the run/fault status of the pressurisation unit.

LTHW Primary Pumps (P1A, & P1B)

During 'normal operation', 1 pump should be scheduled as duty and the other as standby. Upon sensing no-flow condition via the differential pressure switch located across the pumps, the 'standby' pump will be initiated and an alarm raised. Hours run and duty sharing should be incorporated.

Primary pumps shall operate 24 hours a day,

LTHW Secondary Primary Pumps

CT secondary pumps shall run continuously on demand for heat. Flow shall be proved by DP switch. Alarm shall be raised at the BMS in the event of duty pump failure.

VT pumps shall be initiated and shut down by an optimiser algorithm within the BMS software. The optimiser shall respond to outside temperature and inside temperature trend log to open the VT circuit to heating (start) and close (stop) at the optimum time.

The occupancy times shall be set in the BMS software time switch.

The VT circuit flow temperature shall be controlled via a temperature sensor and modulating 3-port mixing valve (mixing application) in response to a software algorithm which relates outside temperature to VT water flow temperature via an adjustable linear characteristic (weather compensation).

During normal operation, one pump should be scheduled as duty and the second as standby. Upon sensing no-flow condition via the differential pressure switch located across the pumps, the 'standby' pump will be initiated and an alarm raised. Hours run and duty sharing should be incorporated. Each pump should be complete with an inverter speed controller.

2.16.3.2 Pressurisation Units

Pressurisation units should run automatically to maintain system pressure. System fault should be raised to BEMS. Pressurisation unit should only shut down in event of 'critical' faults and in event of the integral DP sensor detecting continuous pump operation (timer required).

Shut-down of pressurisation unit should cause LTHW systems to close

The plantroom shall be provided with a gas solenoid valve which shall activate (shut down) in the event of a fire alarm or operation of the thermal links located over the boilers or power failure.

The BMS shall de-activate this control link for normal fire alarm testing via a key switch at the fire alarm panel and local fire alarm interface relay.

2.16.3.3 Energy Meters

Provide energy monitoring to meet the requirements of Building Regulations (Part L), the Energy Log book. Logs of peak demand and cumulative consumption shall be held in the BMS

These shall include water (pulse type) and heat meter.

2.16.3.4 Frost Protection

Provide two-stage frost protection for all closed water systems (e.g. low temperature hot water and chilled water systems).

Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start and circulation is established through pipework systems and

their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.

Ensure that when the return temperature falls below the operator pre-set minimum, the full frost protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.

Protect air handling unit pre-heat coils with a capillary type thermostat (mounted in a serpentine configuration on the downstream face of the coil with suitable support clips). Set the thermostat to operate at an air temperature of +5°C. Use automatic reset type air frost protection thermostats. Ensure maximum switching differential of the thermostat is 2°C. Ensure auto reset frost thermostats operate in conjunction with the frost coil return water immersion temperature sensor.

Provide a facility to allow activation of the frost protection routine to be logged together with date and time.

2.16.3.5 Fire Condition (Assumed existing)

2.17 Thermal Insulation

2.17.1 Particular Requirements

Application and completion shall be of the highest quality and shall comply with the requirements of BS 5422:2009 and BS 5970:2012

The following items are required to be thermally insulated:

- All pipework, (including valves) in plantrooms

All materials shall be asbestos free, non-hygroscopic, not support fungoid life and non-combustible to Class 0 BS 476-7:1997 and Class P BS 476-12:1991.

2.17.2 Pipework Insulation

Pipework and valves shall be insulated using pre-formed mineral wool or phenolic foam sections finished with reinforced foil facing. Insulation shall be secured in position by aluminium bands at 600mm centres.

Insulation shall be cut back at wall sleeves and trimmed.

All pipework routed in unheated spaces or on the flat roof areas shall be thermally insulated as external, with a minimum of 40mm thickness in the roof space.

Insulated valve mats with Velcro fastenings shall be provided which shall cover the whole valve and be easily removable and replaceable.

Pipework within the plantroom areas shall be insulated as above but individually finished in Isogenopak sheet complete with all aluminium capping pieces.

All water pipework, with the exception of final exposed connection to heat emitters and CWS/HWS outlets, shall be insulated. All condensate pipework shall be insulated.

All exposed pipework services with the circulation zones shall be provided with an isogenopak finish.

2.18 Testing and Commissioning

2.18.1 Particular Requirements

The Contractor shall refer to Part One of the specification for general details.

2.18.2 Mains Plant Items

The main plant items, such as the boilers, pumps, pressurisation unit, etc. shall be tested at the appropriate works prior to delivery to site.

The Contractor shall obtain from the manufacturer's certificates in respect of items of plant and equipment manufactured at Works. Upon completion of the install tests, or in sections as appropriate, the Contractor shall prepare record sheets upon which all the test results be shown. Three copies of each manufacturer's certificate and each installation test sheet signed by the Contractor shall be forwarded to the Engineer.

2.18.3 Test Points

The Contractor shall provide sufficient test points to allow full commissioning to be carried out.

2.18.4 Equipment for Testing

The Contractor shall provide all labour, plant, materials, instruments, ladders and scaffolding for carrying out tests.

2.18.5 Test During Construction

During the progress of the work the Engineer may select sections of the installation for testing prior to completion of the entire installation.

2.18.6 Inspection and Testing of Concealed Work

Concealed and buried work shall be inspected and tested in the presence of the Engineer before any permanent covering is applied.

2.18.7 Pre-Commissioning Cleaning and Protection of Equipment

Prior to commissioning entire installations shall be thoroughly cleaned, both internally and externally.

Wet installations shall be flushed out with clean water. During the flushing out, provision shall be made to exclude filters, control valves and other items which would be damaged by the cleaning operation.

Where pressure tests are likely to cause damage to equipment which has a lower test pressure, this equipment shall be removed and connections blanked off for the duration of the test.

2.18.8 Test Procedures and Setting to Work

Test procedures shall comply with CIBSE requirements refer to Part One of the services specification.

Pipework

All heating and cold water service pipework, internal and external, shall be tested to 1.5 times of the final working pressure and shall maintained at this pressure for a minimum period of 2 hours.

Radiators

All radiators shall be submitted to a hydraulic pressure of 100 psi at manufacturer's and after erection and connection to the pipelines, the test pressure shall be 50 psi.

Drainage Systems

a) General

The Contractor shall be responsible for testing and commissioning of the whole of the above ground drainage and overflow system.

The Contractor shall comply with the following:

- Check that all sections of installation are securely fixed and free from obstruction and debris.
- Ensure that all traps are filled with clean water.
- Carry out tests as specified, locate and remedy all defects and reset.
- Keep a record of all tests and provide a copy of each for the engineer.

b) Drainage Pipework Tests

The Contractor shall carry out tests to drainage pipework as follows:

- Temporarily seal open ends of pipework with plugs.
- Connect a 'U' tube water gauge and air pump to the pipework via a plug or through the trap of an appliance.
- Pump air into pipework until gauge registers 38mm.
- Allow a period for temperature stabilisation, after which the pressure of 38mm is to be maintained without loss for not less than 3 minutes.

2.18.9 Instruction of User

The Contractor shall allow for the instruction of two persons, nominated by the Employer in the correct operation of the commissioned plant, controls and system generally.

2.18.10 Defects Liability

The Contractor shall allow for rectifying all faults and damage caused due to failure of the services herein described, and installed under this Contract, for a period of 12 months after practical completion, at no further charge to the Employer.

2.18.11 Delay in Testing

Where prevailing weather conditions prevent the testing of installed equipment to the design conditions, i.e. heat test during summer, the Engineer may defer the test for a maximum period of nine months.

Should the deferred test then prove unsatisfactory, the Contractor shall be responsible for rectification of defects which become apparent and for re-testing the system.

2.19 Schedules

2.19.1 General

Pipework

Service	Pipework	Joints	Fittings
Low pressure hot water heating	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
Medium pressure hot water heating	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
High pressure hot water heating up to and including 125mm diam	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
Chilled water condensate	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
Fire protection services	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
Gas above ground	Black carbon steel heavy to BS EN 12055 random single lengths 4m-7m Copper 50mm & below	Screwed to BS 21 or welded up to 50mm flanged to BS 4504 welded over 50mm	Carbon seamless to BS EN 12055 or steel welding fittings
Hot and Cold Water, Mains cold water	CPVC pipe and fittings Class 2 similar to Durapipe HTA	Solvent welded	CPVC fittings with threaded insert
Heating at high level Overflow and warning pipes (tanks and WC cisterns) Fan coil condensate	Light gauge copper tube to BS 2871 Part 1 Table X	Capillary soldered up to 50mm, welded over 50mm WRC approved	Capilary BS865 type A up to 50mm, weldable over 50mm WRC approved
External mains water below ground nominal size 20-63mm	Blue medium density polyethylene to BS 6572		Compression to BS 864 Part 3
External mains water below ground normal size 90mm and above	Blue Polyethylene to Water Research Centre WIS 4.32.03		Compression to BS 864
Gas below ground	Polyethylene to British Gas Corporation Standard BGC/PA/PL2 Part 1 and BS 3412		Polyethylene to British Gas Corporation Standard BGC/PS/PL2 Part 2

Valves

Application	Service	Size	Type	Crane Option	Oventrop Option	Connections
Isolation	LPHW	Up to 50mm	Bronze ball valve	Crane D171	Oventrop 107.90	Screwed
			DZR Ball Valve	Crane D171A		Screwed
	CHW	65mm & over	Butterfly valve	Crane F628	Oventrop 104.80	Flanged
			Butterfly Valve WRAS	Crane F624		Flanged
	Mains water above ground	Upto 80mm	DRZ stop valve PN20	Crane D151A	Oventrop 104.30	Threaded
		Upto 100mm	Bronze Stop Valve PN20	Crane D151		Threaded
		Upto 80mm	Bronze Stop Valve PN20	Crane D159		Threaded
	Hot and cold water	Upto 50mm	Bronze ball valve	Crane D171C	Oventrop 107.95	Compression
		65mm & over	DZR Ball Valve Butterfly Valve WRAS	Crane D171AC Crane F624		Compression Flanged
	Gas	Upto 50mm	Bronze ball valve	Crane D191	Oventrop 104.81 Oventrop 301.60	Threaded
		50mm to 200mm	Butterfly Valve	Crane F614		Flanged
Non return	LPHW Mains water Hot and cold water	Up to 50mm	Bronze with resilient disc	Crane D140	Oventrop 107.30	Screwed
		65mm & over	Cast iron swing bronze trim resilient seated	Crane FM469	Oventrop 107.30	Flanged
			Cast iron swing bronze trim	Crane FM492		Flanged
	CHW	Up to 50mm	Bronze metal disc	Crane D138	Oventrop 107.30	Screwed
		65mm & over	Cast iron	Crane FM492	Oventrop 107.30	Flanged
Strainers	LPHW CHW	Up to 50mm	Bronze 'Y' type	Crane D297	Oventrop 112.00	Screwed
		65mm & over	Cast iron	Crane FM276	Oventrop 112.00	Flanged
Double regulating	LPHW CHW	Up to 50mm	Globe 'Y' pattern	Crane D921	Oventrop 106.01	Screwed
		65mm & over	Globe 'Y' pattern	Crane DM921	Oventrop 106.26	Flanged
Flow measurement	LPHW CHW	Up to 50mm	Flow measurement device	Crane D901	Oventrop 106.71	Threaded
		65mm & over	Stainless steel wafer pattern	Crane DM900	Oventrop 106.07 + 104.52	Flanged
	LPHW CHW	Up to 50mm	Bronze commissioning set	Crane D931	Oventrop 106.08	Threaded
		65mm & over	Ductile iron globe commissioning set	Crane DM941	Oventrop 106.28	Flanged
Regulation/ Balancing	HWS Return	Upto 25mm	Brass body	Crane D1880 - 1888 WRAS	Oventrop Aquastrom T plus	Screwed
Drain cocks	LPHW, CHW Mains water and cold water	Up to 25mm	Bronze drain tap with hose connection	Crane D340	Oventrop 103.35	Male thread
		Up to 50mm	Bronze draw off cock taper plug type	Crane D344	Oventrop 103.33	Female thread
		Upto 50mm within boiler plant rooms	Bronze ball valve with hose connection	Crane D171MHU		Male thread
	LPHW CHW	Open vented systems Unvented systems	Fig 42 Fig 500	National Vulcan Ltd	.	Screwed or flanged

Application	Service	Size	Type	Crane Option	Oventrop Option	Connections
				Other		
TRV	LPHW	All sizes steel	Brass body nickel plated valve	Danfoss Randall RA9210		
Lockshield + service tool for fill & drain	LPHW	All sizes steel	Brass body nickel plated	Danfoss Randall RLV	Combi 4 - Angle Pattern 109.06	
Automatic air vents	LPHW, CHW	All sizes		Spirax Sarco AE30C	Oventrop 108.82	Screwed or flanged
Flexible pipe connections	LPHW, CHW Hot water	All sizes		Minikin		Flanged
Expansion bellows	LPHW, CHW Hot water	All sizes		Minikin		Flanged
Pressure and temperature relief valves	LPHW	All sizes	Fig 500T	National Vulcan Ltd		Screwed or flanged
3 way vent cocks	LPHW, CHW	All sizes	Fig 503	National Vulcan Ltd		Screwed or flanged

Note: All manufacturers as equal and approved.

Thermal Insulation

Pipework insulation materials:-

Phenolic Foam Pipe Insulation (Suitable for temperatures up to 100ºC)
Rigid hcfc-free "Class O" phenolic foam zero odp, pre-formed bore-coated pipe sections having a nominal density of 35 kg/m³ and thermal conductivity of 0.021 W/m·K at 10ºC mean temperature. Supplied complete with factory applied "Bright Class O" reinforced aluminium foil facing. Kooltherm Pipe Insulation as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

Load Bearing Phenolic Foam Inserts for Pipe Supports (Suitable for temperatures up to 100ºC)
Rigid hcfc-free "Class O" high density phenolic foam zero odp purpose designed pre-formed pipe support inserts and duct support strips supplied with factory applied "Bright Class O" reinforced aluminium foil facing. Kooltherm K-Blocks as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

Mineral Wool Pipe Insulation
Rigid bonded "Class O" mineral wool, pre-formed pipe sections having a nominal density of 80 kg/m³ and thermal conductivity of 0.037 W/m·K at 50ºC mean temperature. Supplied complete with a factory applied "Bright Class O" reinforced aluminium foil facing. Crown SA Pipe Insulation as manufactured by Owens Corning Alcopor Ltd or equal and approved.

Pipe Insulation Thickness: Shall be In accordance with BS 5422:2009 as specified under 2.14.3

Treatment at hangers: Insulation to be carried through between pipes and supports.
Treatment at wall sleeves: Insulation to be cut back and trimmed.

Ductwork insulation materials:-

Phenolic Foam Duct Insulation
Rigid cfc-free "Class O" phenolic foam laminated slabs having a nominal density of 40 kg/m³ and thermal conductivity of 0.021 W/m·K at 10ºC mean temperature. Supplied complete with factory applied "Bright Class O" reinforced aluminium foil facing. Kooltherm Ductslabs as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

Phenolic Foam Slotted Duct Insulation

Rigid slabs as described under A2 are back-slotted to provide sufficient flexibility for application to cylindrical surfaces of 350mm diameter and above.

Load Bearing Phenolic Foam Inserts for Duct Supports

Rigid cfc-free "Class O" high density phenolic foam purpose designed duct support inserts with factory applied "Bright Class O" reinforced aluminium foil facing. Kooltherm Duct Support Strips as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

Mineral Wool Rigid Slabs

Rigid bonded "Class O" mineral wool slabs having a nominal density of 48 kg/m³ and thermal conductivity of 0.034 W/m·K at 10ºC mean temperature. Supplied complete with a factory applied "Bright Class O" reinforced aluminium foil facing. Crown Rigid Duct Insulation as manufactured by Owens Corning Alcopor Ltd or equal and approved.

Mineral Wool Flexible Mattress

Flexible bonded "Class O" mineral wool blanket having a nominal density of 28 kg/m³ and thermal conductivity of 0.034 W/m·K at 10ºC mean temperature. Supplied complete with a factory applied "Bright Class O" reinforced aluminium foil facing. Crown Universal Ductwrap as manufactured by Owens Corning Alcopor Ltd or equal and approved.

THICKNESS TABLES 1 to 7 - in accordance with BS 5422:2001

TABLE 1 Environmental thickness of insulation for non-domestic heating installations to control heat loss. (Reference BS 5422:2001 - Table 12)

Steel pipe size (mm)		Hot face temperature of installation (ºC)				
		+75		+100		+150
		Thickness of insulation (mm)				
NB	OD	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Mineral wool only
15	21	15	30	15	40	50
20	27	15	40	20	40	60
25	34	20	40	20	40	60
32	42	20	40	20	50	65
40	48	20	40	25	50	65
50	60	20	40	25	50	65
65	76	25	40	25	50	75
80	89	25	50	30	60	75
100	114	25	50	30	60	75
150	168	25	50	35	60	75
200	219	30	50	35	60	80
250	273	30	50	35	60	80
300	324	30	50	35	60	80
Vessels and flat surfaces		35	50	40	65	90

TABLE 2 Thickness of insulation for chilled and cold water supplies to prevent condensation on a low emissivity outer surface with ambient air conditions of 25ºC and 80% rh.
(Reference BS 5422:2009 - Table 8)

Steel pipe size (mm)		Temperature of water (ºC)					
		+10		+5		0	
		Thickness of insulation (mm)					
NB	OD	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
15	21	15	20	15	25	20	30
20	27	15	25	15	30	20	40
25	34	15	25	20	30	25	40
32	42	15	25	20	30	25	50
40	48	15	30	20	30	25	50
50	60	15	30	20	40	25	50
65	76	20	30	25	40	30	50
80	89	20	30	25	40	30	50
100	114	20	30	25	40	30	50
150	168	20	40	30	50	35	60
200	219	20	40	30	50	40	60
250	273	25	40	30	50	40	65
300	324	25	40	35	60	40	65
Vessels and flat surfaces		30	50	40	65	50	80

TABLE 3 Environmental thickness of insulation for non-domestic hot water services.
(Reference BS 5422:2009 - Table 13)

Steel pipe size (mm)		Water temperature of 60ºC	
		Thickness of insulation (mm)	
NB	OD	Phenolic foam	Mineral wool
15	21	15	25
20	27	15	30
25	34	20	30
32	42	20	30
40	48	20	35
50	60	20	35
65	76	25	35
80	89	25	40
100	114	25	40
150	168	30	50
200	219	30	50
250	273	30	50
300	324	30	50
Vessels and flat		35	50

TABLE 4 Environmental thickness of insulation for domestic central heating installations (+75ºC) and hot water supply systems (60ºC) to control heat loss in potentially unheated indoor areas with ambient air temperature of -1ºC. (Reference BS 5422:2009 - Table 14)

Outside diameter of copper pipe (mm)	Water temperature of 60ºC/75ºC	
	Thickness of insulation (mm)	
	Phenolic foam	Mineral wool
10	15	25
12	15	25
15	15	30
22	20	40
28	20	40
35	25	40
42	25	40
54	25	50
Cylinders	35	50

TABLE 5 Environmental thickness of insulation for ductwork carrying warm air. (Reference BS 5422:2009 - Table 11)

Temperature difference between air inside ductwork and ambient air (ºC)					
10		25		50	
Environmental thickness of insulation (mm)					
Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
20	40	25	50	35	65

TABLE 6 Thickness of insulation for condensation control on ductwork carrying chilled air in ambient conditions 25ºC, 80% rh. for insulation having a low emissivity finish 0.05. (Reference BS 5422:2009 Table 10)

Minimum air temperature inside the ductwork (ºC)							
15		10		5		0	
Thickness of insulation (mm)							
Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
20	30	25	50	40	75	50	100

TABLE 7 Minimum thickness of insulation required to give protection against freezing under specified commercial and institutional conditions
(Reference BS 5422:2009 - Table 23)

Initial water temperature		**+ 2 ºC**		**+ 2 ºC**	
Minimum ambient temperature		**-6 ºC (Indoor unheated areas)**		**-10 ºC (Outdoor)**	
Evaluation period		**12 h**		**12 h**	
Permitted ice formation		**50 %**		**50 %**	
Pipe size (mm)		**Thickness of insulation (mm)**			
O.Dia	**Bore**	**Phenolic foam**	**Mineral wool**	**Phenolic foam**	**Mineral wool**
Copper pipes					
15,0	13,6	23 (25)	78 (80)	68 (70)	413 (420)
22,0	20,2	10 (15)	23 (25)	21 (25)	58 (60)
28,0	26,2	7 (15)	13 (20)	13 (15)	28 (30)
35,0	32,6	5 (15)	10 (20)	9 (15)	18 (20)
42,0	39,6	4 (15)	7 (20)	7 (15)	13 (20)
54,0	51,6	3 (15)	5 (20)	5 (15)	9 (20)
76,1	73,1	2 (15)	4 (20)	4 (15)	6 (20)
108,0	105,0	2 (15)	3 (20)	3 (15)	4 (20)
Steel pipes					
21,3	16,0	18 (20)	48 (50)	44 (45)	173 (175)
26,9	21,6	10 (15)	21 (25)	20 (20)	52 (60)
33,7	27,2	7 (15)	14 (20)	13 (15)	29 (30)
42,4	35,9	5 (15)	9 (20)	9 (15)	17 (20)
48,3	41,8	4 (15)	7 (20)	7 (15)	13 (20)
60,3	53,0	3 (15)	6 (20)	5 (15)	10 (20)
76,1	68,8	3 (15)	4 (20)	4 (15)	7 (20)
88,9	80,8	2 (15)	4 (20)	3 (15)	6 (20)

NOTE Thicknesses given are minimum calculated specifically against the criteria noted in the table. Adopting these thicknesses may not satisfy other design requirements. Thicknesses shown in brackets are nearest standard thicknesses normally available from manufacturers.

Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing under extreme conditions. In these cases, to provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled circulation of the water or trace heating.

Thickness calculations ignore the specific heat capacity and surface resistance of the insulation.

2.20 Schedule of Manufacturers

EQUIPMENT	MANUFACTURER	CONTACT DETAILS	WEBSITE ADDRESS
Boilers	Hamworthy	Ian.ford@mideng.net	http://www.hamworthy-heating.com
Flue	A1 Flues Midtherm Flue Specialists		
Pumps	Grundfos*	Keith Edmunds -	https://uk.grundfos.com/
Pressurisation Units	Mikrofill*/ existing	03452 606020	http://www.mikrofill.com/
Plate Heat Exchanger	Rycroft		
Strainers	Crane		
Commissioning Stations	Crane Valves		
Dirt/Air Separator	Existing Spirax Hamworthy		

Note

1. * Refers to equal and approved.

2.21 Schedule of Drawings

Drawing No.	Drawing Title
1612/M.01	Proposed Heating Schematic
How Engineering Services	
5980/M/AF/100/701	As fitted Level A Plantroom Heating layout
Record Drawings	
AA39048/WD-5915	LTHW Schematic
AA39048/WD-5604	Plantroom

2.25 Summary of Tender

The Contractor must complete individually each section of this tender summary. It is not acceptable to use the term 'included' against any item as this will invalidate the tender. Each item shall be supported by a detailed schedule of rates which summated to the summary figure. This schedule will be requested prior to acceptance of the tender and will be the basis of pricing variations.

Mechanical Services for IWM Lambeth Road, London Boiler Replacement Project

Item	Description	£
1	Preliminaries, Design and Working Drawings	£
2	Removal of Existing Services	£
3	Boilers	£
	Flue	£
	PHE	
	Pumps	£
	Pipework & Fittings	£
5	Gas Pipework	£
7	Mains Cold Water Modifications	£
9	Acoustics and Vibration	£
10	Automatic Controls	£
11	Thermal Insulation	£
12	Testing and Commissioning	£
13	As Installed drawings and Operating and Maintenance Manuals Including electronic manuals	£
14	12 months maintenance of the entire installation	£
15	Log Book in accordance with Building Regulations Part L	£ .
	Sub Total 1:	
16	Provisional Sum	
	Works to existing services not identified in the documentation	£ 3,000.00
	Commissionability	£ 2,000.00
	Total:	£ .

The above tender includes costs for all specified and required materials and equipment.

Signed ..... Date .....

For and on behalf of .....

.....

.....