

TRADE PREAMBLES

MECHANICAL ENGINEERING SERVICES

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These Trade Preambles shall be retained by the Contractor and referred to at the time of Tender, and complied with when carrying out works on the basis of:-

- (1) Emergency Maintenance and Request Orders
- (2) Specifications for Maintenance Contracts and Minor Works Contracts
- (3) Specifications for Capital Works Contracts.

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PART I

GENERAL

1-1 SCOPE

This specification covers the supply, delivery, erection, installation, testing and commissioning, including repairs and maintenance, to all mechanical services in new and existing buildings. Where any of the work is to be carried out as a sub-contract, 'Contractor' shall mean 'Sub-Contractor'.

All work shall be carried out in accordance with the relevant standards and guidance with particular reference to documents and standards from the following issuing authorities.

British Standards Authority (BS)
Euro norm Standards (BS EN)
Health and Safety Executive (HSE)
Chartered Institute of Building Services Engineers (CIBSE)
Heating and Ventilation Contractors Association (HVCA)
Building Regulations
Institute of Gas Engineers and Managers (IGEM)
Pressure systems safety regulations

1-2 WORKING DRAWINGS

All Working Drawings necessary for accurately and properly carrying out the works shall be prepared by the Contractor and submitted to the Contract Administrator for acceptance in principle, the installation shall not commence until this has been given. Acceptance of drawings submitted by the Contractor shall not in any way relieve the Contractor from his responsibility to provide equipment suitable in dimensions, construction and finish for the location in which it is to be installed.

The Contractor shall produce upon request drawings indicating all builders' work in connection with his works.

It shall be the responsibility of the Contractor to check from site, the accuracy of all dimensions taken from the Authority's or others drawings for use in the preparation of his working drawings.

The Contractor, by agreement with the Contract Administrator, may choose to issue the Authority's tender drawings as working drawings. This will be acceptable providing the Contractor has checked the information and is satisfied that the drawings issued meet his contractual requirements.

1-3 DEFECTS LIABILITY PERIOD

The conditions of contract call for the Defects Liability period to be 12 months unless otherwise noted elsewhere however the Contractor shall after a period of 3 months from the works having been put into use, return to site to make the necessary adjustments to plant, i.e. lubrication and tightening up of all valve glands, checking and tightening all unions and flange bolts, adjustment of pumps, etc. and shall include for these works in his Tender.

1-4 BUILDER'S AND ELECTRICAL WORK

- (a) All necessary Builder's work associated within the contract shall be included for by the Contractor within his Tender and carried out by a specialist Building Contractor, either a builder on the Authority's approved Contractors' list, or other Building Contractor approved by the Contract Administrator unless otherwise identified in the sub-contract conditions. 'Necessary' builders work will be deemed to include the supply and installation of boxing for the concealment of pipework, and the painting and decorating of such boxing as well as uninsulated exposed pipework.
- (b) Holes, chases and any damage to building structure shall be made good and suitably finished by the Contractor. The site of the works shall be at all times left in a clean and tidy condition.

- (c) Any necessary Electrical installation work associated within the contract shall be included for by the Contractor within his Tender and carried out by a specialist Electrical Contractor, either a electrical contractor on the Authority's approved Contractors' list, or other Electrical Contractor approved by the Contract Administrator unless otherwise identified in the sub contract conditions.

1-5 ASBESTOS

- (a) Thermal insulation within the boiler room, ducts and roof spaces, in many instances may, depending on age, contain `asbestos', also asbestos based products were used in the construction of buildings, e.g. ceiling tiles, fire stops inside heaters etc.

An appropriate level Asbestos Survey will have been carried out prior to pre-planned Contracts commencing on site. The Contractor's attention is also drawn to the Asbestos Register which is available on every site, and he shall familiarise himself with the location and form of asbestos-containing materials which may be disturbed or otherwise affected by his works. If, during the contract or any other maintenance or emergency work the Contractor suspects that additional unidentified asbestos may be present, he shall stop work immediately and inform the Contract Administrator in order that the appropriate action can be taken for its removal.

- (b) Removal of any asbestos insulation/materials or drilling of asbestos panels shall only be carried out in accordance with current legislation by a licensed Asbestos Removal Contractor listed by this Authority and in accordance with this Authority's removal and disposal procedure.

1-6 ISOLATION OF EXISTING SERVICES

The contractor shall not isolate existing services without written approval from the employer's representative. Refer also to main contract conditions where applicable. Contractors are reminded that existing pipework and services may be of considerable age, and may not be provided with valves and other straightforward means of isolation. Even if valves exist, they may not be effective. Contractors shall therefore allow in his costs for pipe freezing or such other techniques as shall be necessary to permit isolation and draining down of existing systems.

1-7 REDUNDANT EQUIPMENT

Existing equipment shall be offered to the client prior to removal from site.

1-8 SAFETY AND WELFARE MEASURES

The contractor shall comply with the provisions of the Health and Safety at Work, etc Act 1974, relevant CDM requirements and all other Safety and Welfare statutory measures, where applicable to the works

1-9 FIRE PRECAUTIONS

The contractor shall cease all hot working at least one hour prior to leaving site each day. Hot works permits shall be completed prior to commencing hot works. The contractor shall observe all fire precautions particular to the site.

1-10 INSTALLATION OF EQUIPMENT

All equipment shall be installed in accordance with manufacturers guidelines, applicable regulations and current accepted good practice.

1-11 OPERATION AND MAINTENANCE INSTRUCTIONS

The Contractor shall provide two sets of operating and maintenance instructions for all installations included within the contract. Each set shall incorporate description of such installation of its operation and of the regular maintenance operating routines to be adopted. Each set shall contain copies of all internal and external wiring diagrams for control equipment updated to include all modifications carried out during commissioning, manufacturers data, maintenance leaflets for all items of plant and

equipment, manufacturer's commissioning certificates, and the detailed drawings showing the construction of such plant and equipment.

The Contractor shall be responsible for instructing the occupier's staff in the operation of the completed works.

1-12 **AS INSTALLED DRAWINGS**

After completion of the works, but before the release of any retention money, the Contractor shall supply two sets of paper drawings and an electronic copy of the same drawings in Autocad format., accurately indicating the works of the contract, as actually installed, together with diagrammatic charts, valve charts, damper charts, fuse charts etc., as may be required by the Authority. The scales of these drawings shall be appropriate to the level of detail required. The Contractor shall supply a diagrammatic drawing together with valve/damper chart of the installed plant, and shall fix within the Boiler House protected inside a plasticised covering (as gas charts) and permanently fixed to the wall.

Valve and damper charts are to show regulating valves, commissioning sets, damper positions/volumes, and valve settings.

These drawings and charts etc. are to be prepared in a first class manner to the satisfaction of the Authority.

On all gas installations, a line diagram meeting the requirements of the Gas Safety (Installation and Use) Regulations must be placed as close to the primary meter as possible and a second diagram in the boiler house, indicating the position of all installation pipes, meters, meter controls, valves or cocks, pressure test points, condensate receivers and electrical bonding. These diagrams must be updated after any modification to the gas installation.

1-13 **LABELS AND NAME PLATES**

The Contractor shall supply and fix with nuts and bolts or screws, ivory, Traffolite or other approved labels to all items of equipment, valves, switches, fuses etc., as may have formed part of his works and these labels shall bear such information as is considered necessary by the Authority. The Contractor shall leave in position on all equipment the manufacturer's nameplate or marking normally attached thereto, and no equipment shall be installed without ready means of identifying the manufacturer and pattern or type number, together with the date of manufacture, the output and/or duty as applicable. On pressure sets, the actual commissioning values are to be indicated on the labels.

PART 2**BOILER ROOM INSTALLATIONS****2-1 BOILERS / DIRECT FIRED WATER / AIR HEATERS**

Boilers etc., and their firing equipment shall be as detailed in the Specification or Schedule of Materials, and must be installed in accordance with the manufacturer's instructions.

2-2 BOILERS ETC. EQUIPMENT AND MOUNTINGS

Equipment on boilers, water heaters, and air heaters, shall include the following for each. The position of these shall be in accordance with the manufacturer's standard arrangements, where applicable, or provision made on headers.

- (a) Safety valve or valves, with open end carried to within 300mm of the floor.
- (b) Open vent pipe or expansion vessel
- (c) Altitude or pressure gauge (see section 9-2).
- (d) Thermometer (see section 9-1).
- (e) Emptying cock(s) or drain valve(s) (see section 7-6), fitted external to the boiler casing.
- (f) The name plates giving:
 - (1) maker's name
 - (2) serial number and type
 - (3) output
 - (4) design pressure
 - (5) date of manufacture
- (g) A distinct and easily visible identification number where two or more boilers are provided, and a clear statement of its use, ie. Heating or Hot Water.
- (h) Control thermostat (High/Low/Off) and (On/Off), as specified.
- (i) Limit thermostat, Manual re-set type. (95 deg C max. setting), and capable of generating a remote signal (i.e. change-over contacts).
- (j) On atmospheric plant which has pilot ignition, (i.e. not fully automatic), install a pressure switch in pilot line for remote indication of pilot failure.
- (k) Any thermostats etc. not used for control are to be removed and a blanking plate fitted.
- (l) Where the boiler manufacturer offers an integral control system, this may be acceptable in lieu of (g) to (j)

2-3 BOILER TOOLS

Oil fired and gas fired boilers shall be supplied with a set of flue and tube cleaning tools, appropriate to the boiler. Tools shall be hung on a rack supplied by the Contractor in a suitable wall position .

2-4 BOILER BASES

Boiler bases are to be provided or where existing bases are in a poor state of repair, the Contractor shall be responsible for providing a new concrete base for all new installed boilers, or as specified by the boiler manufacturer. All bases shall be 100mm minimum thickness, and shall extend a minimum of 100mm beyond the boiler casing. Where cast iron sectional boilers have been specified, the base shall incorporate a 6mm mild steel plate in the top surface of sufficient size to support all the boiler feet or other mounting points in accordance with the manufacturer's requirements.

2-5 GAS/OIL FIRED BURNERS

All burners shall be as detailed in a schedule of materials, and all electric motors shall be electrically phased to match in all instances the supply.

All burners shall be installed in accordance with the burner and the boiler manufacturer's recommendations and shall incorporate volt free contacts for (1) lock-out and (2) low gas pressure for remote indication of the alarm condition.

The Contractor shall include for employing the burner manufacturer to carry out commissioning of each new burner, and for forwarding copies of the test certificates to the Contract Administrator on completion.

2-6 BOILER FLUES

Where the installation is to use existing flue pipes the Contractor shall thoroughly inspect the flue-way throughout, joints shall be made good using suitable jointing material to ensure all joints are gas tight. The whole of the smoke pipes and chimneys are to be swept and thoroughly cleaned.

The Contractor shall ensure a good standard of workmanship with the installation of any new flue systems, this shall include:

- (a) secure bracketing, supported from the structure not the boiler.
- (b) gradual sweeps
- (c) good access for cleaning and inspection on all sections
- (d) correct reductions and enlargements as necessary to suit the boiler plant
- (e) single flues and headers are given maximum angle of slope away from boiler into chimney
- (f) drains as necessary
- (g) gas tight joints
- (h) combustion test nipples and plugs
- (i) Data plate in accordance with building regulations

Where a draught stabilizer is specified to be used, any existing draught stabilizer may be re-used providing they are in good working order and can be adjusted to give draught control with the new boiler/burner installation.

Where new flue pipes are to be installed, they shall be cast iron, mild steel, stainless steel, or twin wall as indicated on drawings or Schedule of Materials. All jointing material shall be heat resisting.

All internal sockets in flue pipes must face upwards and joints shall be correctly made with the appropriate heat resisting compound (not fire cement).

No part of any flue pipe or fitting must be less than 50mm (2") from any combustible material. Where a flue passes through any roof, wall or partition, the flue pipe must be enclosed in a sleeve of non-combustible material, and be separated from the sleeve by an air space of not less than 25mm (1") using a suitable fire stop plate.

Where a flue passes through a weatherproof barrier, ie. a wall or roof, suitable weatherproof flashings shall be provided. Care shall be taken where flues pass through proprietary roof membranes and coverings carrying a Manufacturer's extended warranty. In such cases, the Contractor shall undertake the penetration and weatherproofing in such a manner that the guarantee is preserved, if necessary employing an authorised specialist Roofing Contractor to carry out the work.

The connection of flues for forced air burners and atmospheric burners into a common chimney is not permitted.

On all flues where a stabilizer is fitted, each stabilizer must be equal to the cross sectional area of the flue to which it is connected.

Where it is required that the Contractor is responsible for the design of the flue system then a specialist in this field must be employed. The design drawings must be submitted to the Contract Administrator before any manufacture or installation commences.

Where the flue enters a brick chimney the Contractor shall supply a metal sleeve for building in. The space between the sleeve and the flue shall be packed with heat resisting material. The flue pipe shall project not more than 25mm from the inside face of the brick chimney.

All existing flue-ways of any appliance shall be thoroughly cleaned, and the inside surfaces wire brushed. Cleaning of all chimneystacks shall be included for within the Contract.

Where existing flue-ways are to be re-used the Contractor shall allow for any external wire brushing and paint with 2 coats of heat resisting paint.

2-7 OIL TANKS

Drawings of oil tanks shall be submitted for approval prior to placing on order. Oil tanks installations shall comply fully with the requirements of Environment Agency Document PPG2. All oil tank installations shall be constructed from materials suitable for future conversion to bio-oil.

Tanks shall be fabricated from high quality Carbon Steel and be of fully welded construction, incorporating an integral bund with minimum 110% of the inner tank capacity. The tanks will be designed and constructed in accordance with BS799 Part 5 and OFS T200, complying with The Control of Pollution (Oil Storage) (England) Regulations 2001 and current Environment Agency Regulations. The tanks to be of rectangular configuration with suitable stiffening and designed to prevent water traps. The tanks shall be supported from ground level using heavy duty steel sections welded to the underside.

For gravity fed installations, the tanks shall be supplied with a bottom outlet connection.

Tanks shall be fire rated as required for their location.

To prevent external corrosion, the tanks shall be treated with a suitable oil resistant paint system compliant with ISO 12944 category C3 (rural and urban areas) to give a paint design life / durability of 5-15years. The external surfaces of the secondary containment shall be shot blast to SA21/2, followed by 1 coat epoxy zinc phosphate primer and 1 coat polyurethane semi-gloss finish. All surface treatments shall be applied in accordance with the paint manufacturer's recommendations and specified minimum thickness. The tank colour shall be the manufacturer's standard shade of green unless otherwise specified. The tank supplier shall provide details of any internal treatments that are applied to the outside of the inner tank & the internal surfaces of the secondary containment to prevent corrosion, stipulating the design life of the tank and warranty given against internal corrosion.

Each tank shall be equipped with the following:

- Steel lockable fill point cabinet, to house fill assembly, contents gauge, level alarms etc., with a suitable sized full width drip tray to collect all spillages during the tank filling process
- 50mm offset fill assembly c/w ball valve, in-line check valve, 2" BSP fill nipple, non-sparking cap and chain.
- 50mm mechanical overfill control valve.
- 50mm tank vent / o/flow connection discharging into secondary containment.
- 50mm bund vent assembly with rain cap and bird guard.
- 2 No. 25mm BSP sockets on top of tank – one for contents gauge sensor the other sealed with plug as provision for any future instrumentation.
- 150mm dia. contents gauge of the continuous reading type (Landon Kingsway with SLF top entry hydrostatic sensor or similar approved).
- 2 No. 40mm (1 1/2") BSP connection on top of tank for electronic high and low level contents alarm probes (Hytek or similar approved).
- 40mm (1 1/2") BSP connection on top of secondary containment for electronic 'bund level' alarm.
- 20mm BSP bottom outlet c/w external lever ball valve (lockable type with lugs for inserting padlock to secure in both open or closed position) and incorporate an internal ball valve (Environment Agency requirement) with actuator on the top located beneath a 100mm vapour tight cap for emergency use.

- 25mm BSP top entry sludge drain c/w internal pipe cut at 45° and top socket with plug (both tank & secondary containment).
- 25mm BSP dip point c/w internal guide tube, cap & chain.
- All instrumentation shall be clearly marked as to its function and valve handles marked to indicate the open and closed positions.
- The tank shall be clearly labelled at the fill point, stating: type of fuel, maximum working capacity, off-loading and emergency procedures.

The tanks shall each be supplied with a Hytek or similar approved alarm system with appropriate level sensors to provide high and low level tank content alarms and a bund level alarm. Where the tanks are located close to the boiler house the units shall be 240V 1-phase powered from a suitable RCCD protected supply from the boiler control panel. Where tanks are remote from the boiler house the battery powered version of alarm system shall be supplied. The unit shall be clearly marked up as battery powered with the type and number of batteries required. The instructions within the cabinet to include a note to carry out an alarm test before filling commences.

2-8 REMOVAL OF REDUNDANT TANK & EQUIPMENT

The Contractor shall be responsible for employing a licensed waste disposal and carrying company specialising in oil tanks to isolate, drain down and remove from site, with subsequent safe disposal, the redundant tank(s) and any residual oil. The specialist contractor shall also include for the cleaning out of the existing bunds, removing from site any accumulated rubbish and oil contaminated water from the bund and disposing of in a safe manner. Under the 'duty of care' WCC shall required documented evidence along with copies of all relevant licenses and transmittal notes.

Where the volume is significant and will need to be conserved for transferring to the new oil tank. Where the new tank installation is independent of the existing location, the new tank can be installed in advance and the remaining oil in the existing tank transferred over to the new one prior to final decommissioning. The Contractor shall be responsible for arranging with the specialist to carry out this operation using a suitable pump and secure hose to avoid any spillage. An 'in-line' filter shall be incorporated into the transfer line to ensure rust and sludge is not transferred into the new tank. Any residual sludge laden oil shall be removed along with the tank for safe disposal.

On those sites where the existing oil tank will need to be removed before the new tank is installed, the Contractor will be include for the provision of a temporary secure storage tank located in a safe position and the subsequent transfer of oil between existing, temporary and new tanks. The Contractor shall be responsible for ascertaining the quantity of oil remaining at each site and if, with the agreement of the Contract Supervisor, the value of the oil is determined as less than the cost of temporary storage, then the residual oil shall be removed from site by the licensed waste disposal company and the cost identified in the tender summary for temporary storage will be omitted from the contract figure.

The Contractor along with his specialist licensed sub-contractor shall be responsible for establishing the means of safe access on each site for both the transport and craneage needed for the removal the redundant tanks. In addition to the removal of the redundant oil storage tanks, the Contractor shall be responsible for the removal from site of all associated redundant pipework, equipment, rubble, spoil and waste generated in the course of the works and include for it's safe transport and subsequent disposal.

2-9 PRESSURE TESTING OF EXISTING OIL LINES

All sections of new and existing oil supply lines shall be subject to a satisfactory pressure test before the systems are re-commissioned. The pipes shall be tested either hydraulically with fuel oil or nitrogen to a pressure of 0.7barg +/- 0.04bar (+/- 0. 5lb/in²) for 30 minutes with an allowable pressure variation of -0 barg / +0.04barg (0. 5lb/in²) during the 30minutes. The WCC Property Services Department must be informed if any of these pipe lines fail the pressure test. The test results and dates shall be recorded on a chart locally to the test point and in the school's H&S file so that the tests can be repeated at 5 year intervals. To facilitate these initial and future repeat tests on buried pipework systems, WCC will require suitable valved test points (1/2" bsp) to be incorporated into the oil supply line at the point of entry to the boiler room.

2-10 OIL TANK LINES AND FITTINGS

Oil tank lines and fittings shall be suitable for future conversion to bio-oil and contain no natural rubber components.

(a) Unless otherwise indicated the oil feed lines shall be provided with the following :-

- (1) Fuel type filters with isolating valves and drain cock.
- (2) A bulk oil flow meter.
- (3) A valved by-pass for insertion of a test meter.
- (4) An electrically operated fire valve located in a suitable enclosure outside the boiler room.

Buried oil feed lines shall be of twin wall or pipe in pipe construction with visible leak detection "tell tales"

(c) The fire valve system shall be arranged as follows :-

24V or 240V electrical normally closed fire valve system incorporating thermal fuses shall be provided, suitably positioned over the burners. Any electrically operated system shall be self-resetting on restoration of the mains power supply following an interruption.

The whole shall be arranged so that in event of the thermal fuse(s) operating, the fire valve will close and the electricity supply to the burner controls will be isolated. A local or remote alarm, as appropriate, shall be raised.

A hand operated wheel valve shall be provided on the tank side of the fire valve.

2-11 FOAM INLETS

Existing and new foam inlets shall be galvanised pipe and fittings, the inlet connection shall be of brass or gunmetal to suit the requirements of the Local Fire Brigade or Fire Service as required, and shall be identified by a White Plastic Plate not less than 100mm long x 75mm high with an inscription engraved in 10mm Red lettering, stating "FOAM INLET" and clearly setting out the area served.

2-12 FIRE SAFETY CONTROLS (GAS)

Gas fired boiler plant unless otherwise indicated shall be equipped with the following safety controls:

- (a) Emergency "knock-off" switch.
- (b) Bi-metal fixed temperature heat detector, over each burner.
- (c) Solenoid type gas safety and "shut-off" valve.

Gas safety "shut-off" valve shall be of the fast closing / slow opening type and shall be sized to give negligible pressure drop.

The emergency "knock-off" switch is to be situated near the Boiler Room entrance door, and mounted 1.5m from finished floor level away from the light switch and preferably on the opposite of the door. Where two entrance doors are provided a K.O. switch is to be provided adjacent to each. The "knock-off" switch shall be of the dual contact metal clad type. Plastic switches must not be used.

Fixed temperature detectors fitted over each boiler/burner shall be completely separate and independent of the fire alarm system fitted in the premises.

All fire safety circuits are to automatically reset in the event of power failure. Manual reset equipment is not to be used. Gas fired plant shall be equipped for automatic ignition; permanent pilot plant shall not be used.

In addition to the above, gas-fired plant installed in underground plant rooms or boiler rooms in residential premises shall be protected by an electronic gas detector system of proprietary manufacture as specified elsewhere in the detailed Specification. The gas detector system shall be arranged to shut down the gas supply to the plant safely, and raise a local and remote alarm, without operating the Fire Alarm system.

2-13 **MAIN GAS COCK**

The main gas cock shall be located in a safe accessible position where the main enters the Boiler House, except where an alternative safe location is requested by the Fire Authority.

2-14 **INSTRUMENTATION**

In all Boiler Rooms dial type thermometers shall be fixed in each boiler flow, each zone heating flow and return, and adjacent to any further automatic control sensor positions. A dial type thermometer shall be fixed similarly in the common flow main from the three port valve adjacent to the control sensor. The dial type thermometer shall be as specified in Clause 9-1.

Domestic hot and cold water services shall have dial thermometers on HWS flow and return connections to water heaters. Specific positions for automatic control temperature sensors are in HWS flow and return, CWS down-feed and CWS storage cisterns.

2-15 **BOILER HOUSE CLEANING AND PAINTING**

(a) **Wall and Ceilings**

When substantial work such a boiler replacement is undertaken the Contractor shall allow for the Boiler House to be wire brushed on all walls and ceilings, washing down where necessary, and removing all loose debris, sealing all surfaces and for painting with two coats of good quality white vinyl emulsion paint. All works to be left in a satisfactory manner. Whilst this work is being carried out all equipment shall be protected.

(b) **Floors and Boiler Bases**

The Contractor shall allow for the boiler house floor and boiler bases to be thoroughly cleaned down, all holes, cracks etc. shall be stopped and the whole of the surface to be brushed down to remove dust and loose materials.

In addition all traces of mould/oil shall be removed by scrubbing with water and detergent and rinsing with clean water.

All surfaces shall be painted and sealed as recommended by the paint manufacturer.

Colours as follows:-

Floors– BS4800 Range Heavy Duty Floor Paint “Tideway” 18 B 21
– Upstands, Boiler Plinths etc – Tile Red (Leyland Paints) or other approved (no BS number applicable)

2-16 **REFRACTORY LININGS**

- (a) Where during any refurbishment of plant, it is required that the burner only is to be replaced, and the boiler is to remain as existing, the Contractor shall allow for all refractory linings and brickwork to be replaced, and due allowance must be made for materials and labour for any necessary modifications.
- (b) Combustion chamber linings shall be installed to comply with any specified requirements of the burner or appliance manufacturer. Linings and brickwork shall be installed to give necessary protection to exposed metal services, and allowance made during installation for subsequent expansion of the material.
- (c) Refractory lining cement shall be of a good quality with joint thickness not exceeding 10mm.

2-17 FRONT PLATE WORK

- (a) The burner mounting front plate shall be manufactured from 10mm thick mild steel plate, this shall be securely bolted to the boiler front and sealed with a suitable heat resistant gasket (not fire cement).

A suitable fireproof mastic shall be used around the outside of the platework to ensure a gas-tight joint has been made. A smooth neat finish is required.

- (b) An armoured glass viewing port as Kingsway manufacture shall be fitted by the Contractor to the front plate work of the appliance or existing replaced in order to observe the burner flame, etc.
- (c) All existing inspection and cleaning doors are to be replaced with mild steel plate, made to permanently fix to boiler to ensure a positive seal of flue gases.
- (d) All new plate work shall be painted with one coat of red oxide primer, and one coat of black gloss heat resisting paint.

All modifications to the original boiler shall be approved by the boiler manufacturer.

2-18 GAS METER HOUSES

Gas meter housings shall normally be of the GRP type and included in the contract to bring a gas supply onto the site. The specification for the construction of foundation and meter house shall be as described elsewhere.

2-19 BOILER HOUSE VENTILATION

High and low level ventilation shall be provided in accordance with the appropriate British Standard, Gas Safety Regulations and the boiler manufacturer's requirements. Should this be provided by the use of louvered boiler house doors the following specification shall be used:

The Contractor shall allow for fitting new boiler house door(s) and frames as follows:-

- Take off existing door or pair of doors and cart off site. Inspect the door frame and inform the Contract Administrator of any additional repairs before proceeding further.

Replace doors with a single or pair of doors, as required, of louvered doors to be constructed as follows:-

- Doors shall consist of ex 125 x 50mm stiles and top rail, with ex 200 x 50mm middle and bottom rails, join members using mortice and tenon joints, all glued tight and square.

Louvered Panels shall consist of 50mm x 19mm thick louvres housed into 35 x 19mm louvered stiles at 60 degrees, to the horizontal at 25mm centres. Glue & pin louvre panels into door. Where specified, the Contractor shall provide a 15mm marine ply board fixed behind the louvered panel offset such as to permit adequate ventilation, but prevent draughts. Insect screens/bird mesh shall not be fitted.

Ironmongery - hang door(s) on 1.5 pairs 100mm steel butt hinges per leaf. Supply and fix SAA lever handles and matching escutcheon, one set per leaf. Fix only mortice dead lock as supplied by the Authority Free Issue.

Decoration - prepare and apply a protective coating system consisting of one priming coat, one undercoat and hard gloss finish. Colours are to match existing paintwork.

2-20 BOILER HOUSE LOCKS

Where existing doors are being reused the Contractor shall allow for fitting only, new door lock as supplied by the Authority Free Issue. Keys are to be given to the Contract Administrator for distribution.

PART 3**PUMPING EQUIPMENT****3-1 CIRCULATING PUMPS**

Circulating pumps and their equipment shall be as detailed in the Schedule, Specification of Materials, or drawings.

The Contractor shall provide and fix circulating pumps with valves fitted to both suction and discharge pipework. The contractor shall ensure that variable speed pumps are programmed to operate as specified.

Where dual pumps are specified, a non-return valve is to be fitted on the downstream side of the pump, between the pump and the discharge gate valve, unless included in the pump set arrangement.

Altitude gauges shall be connected to the main on each side of the circulating pump, or pair of pumps and set to the pump operating pressures. Where duplicate pumps are provided gauges shall be connected in the common suction and delivery mains inside the isolating valves on the pump or pump set, for ease of maintenance. Where possible, the gauges shall be wall mounted at the same horizontal level and provided with flanged backs. In all other respects they shall be in accordance with Clause 9-2.

Where a Contractor is replacing new pumps for old, similar phasing of pumps shall be used wherever possible, i.e. 3 phase for 3 phase, and the Contractor shall check that the electrical overloads are suitable for the new pump, and where necessary include for replacement overloads to be fitted, and checking for correct rotation.

Multiple pumps shall not be fitted in HWS circuits. In such instances, a single bronze HWS circulating pump shall be fitted in the return connection and a new identical spare pump, adequately capped and protected in clear plastic, shall be supplied and fitted on purpose-made brackets in an adjacent position. Flanges or unions shall be provided to simplify pump replacement. Electrical supplies shall be by means of an industrial plug-and-socket with flexible cable, suitably protected, to facilitate pump replacement by a mechanical tradesman without the need for electrical wiring alterations.

3-2 OIL CIRCULATING PUMPS

Where oil circulating pumps are to be fitted, they shall be suitable for the viscosity and temperature of the grade of oil to be pumped. Each pump shall be fitted with an integral pressure relief valve and isolating valves shall be provided on the suction and discharge side of the pump. Pressure indicating gauges and air release valves to be fitted.

3-3 PRESSURE BOOSTER SETS

Pressure booster sets shall be as indicated in the Specification.

Pressure booster sets unless specified otherwise shall be for intermittent operation, and shall be fitted with an expansion vessel and the necessary pressure switches.

A manual reset facility is **NOT** to be fitted. The Contractor is to ensure that the whole of the systems connected to the set are suitable for the maximum delivered pressure, and that the set is located away from any external louvres so as to minimise the likelihood of freezing up.

Multiple pump booster sets for CWS duty shall have automatic duty/standby pump changeover every 8 hours to prevent stagnation in the non-running pump.

All pressure sets are to be installed in accordance with the manufacturers instructions, and the set is to be commissioned by him on completion. The expansion vessel and pressure switches are to be provided with a label indicating the pressure settings required, established after commissioning. Label to be permanently secured to pressure set with fixing screws or bolts. A full commissioning report must be included in the operation and maintenance instructions (Clause 1-6).

When a pressure set is used as a make-up supply to a closed heating system, the system shall be fitted with a fast fill connection, incorporating a stopcock, pressure reducing valve and suitable hose connection. The heating system shall not be filled using the make-up set. An isolating lockshield valve and drain cock is required between the expansion vessel and the system, so that the vessel can be drained, and the air pressure checked for maintenance purposes.

Where the pressure set incorporates a make-up tank, a suitable overflow arranged to discharge in a suitable location, shall be provided.

Pressure sets are generally not recommended for closed heating systems. The favoured systems are (a) a conventional feed and expansion tank, or (b) a proprietary, WRC-listed mains-connected pressurisation system as Mikrofill or equal and approved.

3-4 **CIRCULATING PUMPS GENERALLY**

All circulating pumps shall be fitted with a metal identification plate giving the manufacturer's name and address, pattern, serial number, duty in litres/second, frictional head in kN/m² and RPM. The plate shall be securely fixed to the pump, or base plate.

The Contractor shall make sure that any pump fitted is operating with a desired static head to the manufacturers recommendations, that the position of the motor shaft is as recommended by the manufacturer, and that the pump is rotating, and is installed to pump, in the correct directions.

Pumps are to be capable of operating continuously under the maximum static head of the system and the water temperature of the system.

Where canned rotor pumps are installed the Contractor must ensure that they are fitted such that at no time can the pump air lock, i.e. the top pump on a set fitted horizontally shall be installed on a drop loop from the flow main.

Where recommended by the manufacturer, the Contractor shall fit an automatic air release valve to the pump.

Where pumps are mounted one above another and there is the possibility of water from the upper pump glands or seals dripping onto the lower pump, then a suitable shield must be installed to deflect the water.

PART 4**INSTALLATION OF PIPEWORK SERVICES****4-1 L.T.H.W. SYSTEMS INSTALLATION**

Joints on all pipework, 65mm diameter and above, and all pipework concealed in voids, chases, ducts, lofts and ceiling spaces shall be welded. All other pipework shall be screwed or welded joints. Grooved pipe jointing methods such as Victaulic may be accepted for use in accessible locations, subject to prior approval. Where the Contractor elects to use screwed joints at least one of two engaging components shall be taper threaded and the jointing between them shall be made with approved jointing material. The use of linseed oil-based jointing compounds shall be limited to heating systems only.

At dismantling points, or where the pipework is connected to an appliance, ground-in spherical seated Navy-pattern unions shall be used for pipework up to 50mm size, and flanges shall be flat faced BS 10 Table "D" and "E" if required to connect to equipment having flanges of Imperial size, otherwise flanges shall be raised face BS 4504 Tables 6/2 or 6/5 where the joints are welded and Table 6/4 where the joints are screwed. Flanged joints shall be made with a flat or corrugated ring gasket suitable for the pressure and the temperature and extending to the inside of the bolt circles. Full joints shall not be made with raised faced flanges.

Screwed fittings other than sockets shall be malleable cast iron banded or beaded pattern, screwed BSP thread. Standard butt welding fittings shall be used on welded pipework.

Flanges for mild steel pipework shall be forged steel machined over the raised or flat faces. Headers shall be of flanged mild steel tube with flanged outlets welded on and spare outlets shall be blanked with bolted flanges.

4-1.1 L.T.H.W. SYSTEMS AND PRIMARY H.W.S. SYSTEM PIPEWORK

Black Mild steel to BS EN 10255 Heavy weight or Copper to BS EN 1057 Grade R250.

Galvanised tubes shall be used for foam inlets, drains, open ends from safety valves, etc.

4-2 COLD FEEDS AND VENTS (all piped systems)

Light gauge Copper to BS EN1057 Grade R250.

Galvanised MS to BS EN 10255 shall only be used where alteration or repair work to existing systems where galvanised steel is already installed. Where replacement feed and vents are specified, these shall be installed in copper pipework.

4-3 D.H.W. AND COLD WATER SERVICES GENERAL

Work to domestic hot and cold water services shall only be undertaken by a Contractor, Sub-Contractor or operative who is registered under the "Watermark" Approved Plumbers Scheme operated for the time being by Severn Trent Water, or other equal and approved Quality Assurance scheme.

All work shall comply with BS 6700:1997 'Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilage' and the HSC Approved Code of Practice L8 'The control of Legionella bacteria in water systems' and conform to the Water Supply (Water Fittings) Regulations

All jointing shall be suitable for potable water supplies and the Contractors notice is particularly drawn to the fact that linseed oil-based jointing compounds ("Boss White" or similar) are expressly prohibited from use on potable and HWS/CWS systems.

All copper pipework to be best quality, kite marked and protected from any contamination as cement dust. Joints shall be made using lead-free solder and the minimum amount of water-soluble flux of a

type approved and WRc-listed for domestic water services, all residues to be removed by thorough flushing with clean water prior to commissioning.

Repairs to existing domestic hot or cold water pipework in galvanised mild steel shall have tapered screwed joints, with jointing compound approved for potable water, and fittings shall be galvanised. Alternatively, compression fittings of the Viking-Johnson type may be used. Galvanised pipework is not to be welded, and not used on new installations.

Fittings for copper pipework up to and including 65mm size shall be of the capillary or the compression type BS 864 Part 2. All capillary fittings shall have lead-free solder ring and be suitable for potable water duty, as Yorkshire Potable or other equal and approved.

Fittings for copper pipework of 80 mm and 108mm size shall be of the flanged compression or capillary type. Fittings for pipework above 108mm size shall be flanged or brazed.

Pipe fittings of the press-fit pattern incorporating a neoprene rubber seal shall NOT be used.

Pipework shall be arranged with adequate connection points to allow easy dismantling. Connection points in copper pipework up to and including 65mm size shall be union or demountable compression joints and for pipework of 80mm size and above shall be flanged. New Hot water dead legs are not to exceed the following lengths: at 60°C max length 5.0 metres; at 43°C downstream of a blending valve max length 2.0 metres, with an overall maximum of 5.0 metres in every case. Length of dead-leg to be measured from the centre of the running main to the point of discharge, including any flexible shower hose.

Where pipework is stripped out deadlegs shall be no longer than 5 pipe diameters in length. Where practical redundant tees should be removed and replaced with straight lengths of pipe.

The Contractor is to include for rigid final connections to all taps, cisterns, etc with isolation valves to individual items or ranges of basins as specified. Flexible hoses will not be permitted on any domestic hot and cold potable water system, unless the flexible hose forms an integral part of a WRAS-approved tap or water fitting. Final connections to taps, cisterns and appliances shall be made using rigid pipework by site-made sets and bends and approved pipe fittings or, if a flexible connection is specified, all-metal flexible fittings shall be used. **Under no circumstances will rubber-lined flexible braided hoses be accepted for final connections without the prior approval of the Water Quality Manager, Chief Engineer or their representative.**

Where the incoming cold water main is run underground other than in ducts, it shall be laid with a minimum cover of 750mm below finished ground level from the connecting point 1m outside the building until it is within the building. The Contractor shall lay 150mm wide blue magnetic marker tape with metal insert for tracing pipe location and labelled "CAUTION BURIED WATER MAIN". This tape shall be laid during backfilling, 450mm above pipe, 300mm below finished ground level for the whole length of the trench. Tape to be as Campbell type 051 or other equal and approved.

The Supervising Officer and/or Regulations Inspector from Severn Trent Water is to witness the installation at all points prior to the completion of backfilling.

The trench bottom shall be of constant depth and free from sharp stones, bricks etc. All backfilling shall be carried out using granular pea gravel, 10mm single size aggregate to BS 882, with 150mm layers below and above the pipe. Final backfill shall be selected earth, compacted level with the surrounding area.

Pre-cleaning and disinfection shall be carried out to all water supply installations for both hot and cold water generally in accordance with BS 6700. The Authority's requirements for sterilising systems using liquid 'Chlorine Dioxide' are given in PART 12 - Testing and Commissioning, and this work shall only be undertaken by an approved Specialist Sub-Contractor

4-4 DOMESTIC HOT AND COLD WATER SYSTEMS PIPEWORK

Pipework shall generally be: Light gauge Copper to BS EN 1057 Grade R250.

Pipework within showers and other wet areas: Light gauge copper to BS EN 1057 Grade R250 chromium plated with chromium plates fittings or stainless steel throughout. Compression fittings shall

be used.

Buried Pipework / external trenches: Medium Density Polyethylene blue pipe for potable water supplies to BS EN 12201.

Non-potable water pipework (recovered rainwater) for WC flushing: ABS pipework, solvent welded. Pipework, fittings and installation in accordance with HVCA Guide TR/11; BS 5391; BS 5392; BS 5955; BS 6209.

4-5 **WARNING NOTICES FOR SANITARYWARE**

Unblended hot water outlets shall have appropriate hot water warning notices clearly displayed.

Shower installations shall be labelled as follows: "Water Hygiene: the occupier is responsible for flushing this appliance at least once per week when not in regular use, and for recording this action in the site water quality records".

The label should be permanent, such as engraved 'Traffolite' or similar, measuring approximately 100 x 75mm with black lettering on a white background, and permanently fixed in such a position so that it can be readily seen but is not subject to water spray or continual moisture.

4-6 **GAS SERVICE INSTALLATIONS GENERAL (NATURAL & L.P.G.)**

All gas works shall comply with the Gas Safety (Installation and Use) Regulations 1994 (SI 1994 No.1886), all current procedures as issued by the Institute of Gas Engineers. (IGE/UP/1 to 8), and all operatives used on such work shall be competent and hold the appropriate ACOPS certificates for the elements of work undertaken all as required and defined by the current gas safety authority.

The Contractor shall provide "as installed" layout drawings of all gas pipework. The drawing shall be encapsulated in plastic laminate and fixed at the meter position(s), (Natural Gas), or second stage governor position (LPG) and a copy in the boiler house.

4-7 **GAS SERVICE PIPEWORK ABOVE GROUND (NATURAL GAS & LPG)**

All locations internally:

Mild Steel to BS EN 10255 (Heavy) - pipe sizes up to 40mm
Mild Steel to BS EN 10255 (Medium) - pipe size 50mm and above

All joints to be screwed, and jointing compounds shall be suitable for the type of gas in use.

All concealed locations internally and externally exposed locations:

Mild Steel to BS EN 10255 (Heavy) - all pipe sizes welded throughout. Pipework within trenching shall be Denso wrapped.

In certain approved locations where detailed by the Supervising Officer:

Light gauge copper tube to BS EN 1057 GRADE R250 , with capillary fittings may be used. This will not apply in educational establishments unless the pipework is concealed or otherwise protected from mechanical damage.

L.P.G. gas pipework in galvanised mild steel, shall have tapered screwed joints, fittings shall be malleable beaded. All jointing materials are to be suitable for L.P.G. PTFE tape, or Calorite, to provide a gas tight seal. Boss white/hemp joints shall NOT be used on L.P.G. pipework. All pipe threads shall be carefully cut.

Final connections on all L.P.G. pipework shall be in copper tube, jointing shall be compression fittings by WADE, SIMPLEX or other equal and approved with plain parallel soft copper olives (often known as ferrules/rings). The manufacturers recommendations on tightening shall be carefully followed.

NOTE: There is **NO** acceptable level of leakage with L.P.G. Installations shall be totally gas tight.

Joints for external steel pipework shall be butt welded and fittings shall be BS 1965 (Heavy) seamless

For natural gas Fittings for mild steel pipework inside the buildings shall be malleable with taper screwed joints as specified in Clause 4-6. Jointing material shall comply with BS 6956 part 5 and 6, no hemp is to be used on pipework up to 40mm dia., and only limited quantities used on larger pipework which shall be suitably trimmed.. Fittings for copper pipework shall be as detailed above for LPG, and joints made only in exposed locations, ie. in laboratories above floor level and below the benches

Internal pipework shall be arranged for easy dismantling. For this purpose the Contractor shall provide unions at intervals not more than 24m on pipework up to and including 50mm size where these are to be connected to equipment having flanges of Imperial size, otherwise they shall be to BS 4504 Tables 6/2 and 6/5. Flange joints shall be made with flat or corrugated ring gaskets suitable for the pressure and extending to the inside bolt circles.

Completed gas supplies where exposed shall be painted with one coat of red oxide primer/undercoat and finished with one coat of yellow ochre to BS4800 08 C 35.

Gas test nipples are to be provided not more than 1.0m on outlet side of meter and to each appliance being served by Gas. Each science laboratory shall have at least one test nipple.

A clearance of 150mm shall be maintained between gas pipes and electric cables, conduits etc., on internal pipework installations and above ground external installations.

The contractor shall include for final connections to all gas taps, boilers, fume cupboards, meters etc

4-8 **BURIED GAS PIPEWORK**

Buried pipework: shall be MDPE yellow tube to BS 7281 with integral magnetic marker strip. Short lengths of buried pipework where specifically identified on the drawings shall be carried out in Mild Steel to BS EN 10255 (Heavy).

The Contractor shall lay and fusion joint gas pipework in polyethylene using the service tools and fusion machine specified and required by the manufacturer. All Operatives employed to carry out this work, shall be formally trained in the process and hold an approved ACOPS certificate.

The Contractor shall allow for the final 1.0 m length prior to the pipe/tube rising from trench to be run in Mild Steel Heavy tube (welded), and wrapped in two layers of Denso tape. Alternatively a purpose made close fitting sleeve can be used to cover the whole of the internally exposed tube and providing complete heat and fire protection to the MDPE pipe within, as required by the current Gas Safety (Installation and Use) Regulations.

Where polythene tube is being connected to steel pipes the Contractor shall carry out the jointing using the manufacturers approved transition fitting. Pipes up to 63mm dia. - ADAPTORS - PE/BSP female for service pipe. Pipes above 63mm dia. - FLANGE ADAPTORS - PE/BS4504 - PN 16 or BS 10 Table D/E. Both forms of transition fittings are fusion welded to the polythene pipe and provide for screwed or bolted flange connection to metal pipes, valves or other ancillary equipment. The Contractor shall ensure that a liner or insert is installed to support the bore of the pipe to give long term performance of the compression seal as recommended by the manufacturers. The Supervising Officer is to witness the installation at all joints and pressure testing prior to the completion of backfilling. Under no circumstances should steel grips or wrenches be used on plastic pipe or plastic compression fittings.

All steel pipework buried in the ground shall be rubbed down free from rust and painted with red oxide and further protected against external corrosion by the use of double DENSO Tape wrapping with overlap as required by the manufacturer.

The Contractor shall mark out the position for trenches. Pipes/tubes shall have a minimum earth cover of 750mm. In special locations where excessive loads/vibrations may occur, ie under roads/car parks, the Contractor shall agree with the Contract Administrator the extra depth/protection necessary.

Where a common excavation is made for gas pipes/tubes and electric cable a minimum horizontal clearance of 300mm shall be made between the two services within the common trench.

The trench bottom shall be of constant depth and free from sharp stones, bricks etc. All backfilling shall be carried out using granular pea gravel, 10mm single size aggregate to BS 882, with 150mm layers below and above the pipe. Final backfill shall be selected earth, compacted level with the surrounding area.

The Contractor shall lay 150mm wide yellow marker tape with metal insert for tracing pipe location and labelled "CAUTION BURIED GAS MAIN". This tape shall be laid during backfilling; 450mm below finished ground level for the whole length of the trench. Tape to be as Campbell type 053 or 054 or other equal and approved.

4-9 OIL FUEL LINES

- (a) Steel pipework shall have all welded joints with standard butt welded fittings. Joints and fitting for copper pipework shall comply with Clause 4-8 except that soft soldered fittings shall not be used and compression fittings shall be used only where required to facilitate dismantling.
- (b) Oil lines shall be painted gloss brown
- (c) Oil pipes or lines shall be installed so as to provide ample facilities for inspection and maintenance of plant and equipment.
- (d) Oil meters where specified shall be installed where convenient for inspection, and complete with filters.
- (e) Oil supply pipes shall preferably not be run in floor trenches or chases, but should be run on a wall behind the boilers, and down the side of each boiler to the burner. The latter method must be adopted in existing Boiler Houses to avoid cutting floors.
- (f) Where oil lines vents and fill points are not required on the new installation due to plant being converted to gas firing or otherwise, the oil lines shall be totally removed, the connections to the tank plugged off, and all existing holes and trenches made good.
- (g) Refer to oil tank installations for specific requirements relating to buried oil lines

4-10 PIPEWORK INSTALLATIONS GENERAL

- (a) All fittings shall, as far as practicable, be the same size as the tubes and pipes connected to them. Reduced socket outlets will only be accepted if the required outlet size of a fitting is not of standard manufacture. Eccentric reducers and square tees shall be used where concentric reducers and pitcher tees might cause air to be trapped in the system. Elsewhere square tees shall be confined to dead-leg branches of DHWS systems and on cold water branches to fittings or ranges of fittings.
- (b) Bends shall be used, where practicable, in preference to elbows: square elbows will **NOT** be permitted.
- (c) Pipework shall follow the contours of walls and shall be graded to ensure positive venting and draining. The clearance between pipework (or the lagging) and the wall, and any other fixtures shall be not less than 25mm.
- (d) Purpose-made sets or springs may be used where necessary to deviate from a straight run in ungalvanised pipework.
- (e) Sets or springs in tubes of 50mm size and above shall be fire-made and the tubes shall remain circular after setting. In galvanised pipework deviations shall be formed from standard fittings.
- (f) Eccentric reducing sockets shall be used where changes of bore are made in runs of nominally horizontal pipework to facilitate air venting and drainage.

- (g) Metal-arc welding shall comply with BS 2971. Welding shall comply with BS 264. The execution of welding and the competence of the welder shall be in accordance with "Recommended Practice and Tests for Certificates of Competency of -Oxy-acetylene and Metal-arc Welds in Mild Steel Pipework" issued by the Heating and Ventilation Contractors Association. .
- (h) The Contract Administrator shall have power at any time to ask the Contractor to demonstrate the quality of the welder's work in accordance with BS 4872 Part 1, at no additional cost.
- (i) When visual tests on completed work indicate that the quality of welding could be below standard, the Contract Administrator shall be entitled to have the welds examined by radiography as a test of acceptability. Such test to be chargeable to the Contractor if work is found to be substandard.
- (j) Tubes shall be reamed after cutting and shall be free from burrs, rust, scale and other defects, and shall be thoroughly cleaned before erection. Open ends left during the progress of work shall be temporarily closed with purpose-made metal or plastic plugs or caps, or blank metal flanges.
- (k) Joints shall not be made in the thickness of any wall, floor or ceiling, and pipework shall not be embedded in the structure of floors unless otherwise instructed by the Contract Administrator. Where pipework passes through walls, floors or ceilings, sleeves shall be provided and fire compartmentation maintained. Spaces between pipe wall and sleeve shall be packed with mineral wool or other approved vermin-resistant and fire-retardant material.

Pipework passing through floors, ceilings and walls where visible shall be provided with approved floor, ceiling or wall plates. Plates are to be fixed to the sleeves or structure, not to the pipe.
- (l) All entry and exit holes to or from building for pipework services shall be sealed and plugged. For service condition below 60°C the sealant shall be mastic compound, above this temperature it shall be silicone rubber.

Where the pipework enters the building through a large hole or duct a mild steel blanking plate not less than 6mm thick shall be built into the walls of the hole or the duct; the service pipes shall pass through clearance sockets welded to the plate, and the space between the pipe exterior and the socket interior shall be sealed and plugged, and as far as possible made water-tight. The plate to be suitably painted to match the existing décor.
- (m) Flow headers, Return headers and low-velocity headers, where indicated, shall be welded with flanged connections. Each circuit isolating valve shall be connected direct to a vertical flanged outlet on top of the headers. On the circuit side of the isolating valve, the Contractor shall fit a drain cock and a 100mm diameter thermometer. Each circuit return shall be valved as required, the header shall be horizontal, and the thermometers, drain cocks and circuit isolating valves shall be arranged at common horizontal levels. A non-return valve shall be supplied and installed in each heating return circuit connection to the header, to prevent unwanted circulation under part-load and timed operation of individual zones.
- (n) Internal pipework shall be arranged for easy dismantling. For this purpose the Contractor shall provide unions at intervals not more than 24m on pipework up to and including 50mm size where these are to be connected to equipment having flanges of Imperial size, otherwise they shall be to BS 4504 Tables 6/2 and 6/5. Flange joints shall be made with flat or corrugated ring gaskets suitable for the pressure and extending to the inside bolt circles.
- (o) Unfixed pipework stored on sites, shall be raised off the ground on racks, and the open ends protected, to prevent the ingress of any foreign matter.
- (p) Where shown on the drawings or necessary for aesthetic reasons, pipework shall be insulated and concealed by purpose-made MDF or timber boxing, neatly finished and having removable access covers where necessary, all painted or decorated on completion to achieve a standard of visual appearance acceptable to the Contract Administrator.

- (q) No mechanical pipework joint shall be buried. If it is necessary to have a mechanical joint underground a permanent brick built access chamber with removable steel cover shall be provided and the joints made within the confines of the chamber.
- (r) Mechanical joints (screwed / compression) shall not be made in ultimately inaccessible locations such as above false ceilings. Any welded or brazed joint that is permitted in such locations shall be pressure-tested and witnessed by the Contract Administrator or his representative before being concealed.

4-11 PIPEWORK SUPPORTS, EXPANSION AND ANCHOR POINTS

Pipework shall be adequately supported in such a manner as to permit free movement due to expansion and contraction. Pipework supports shall be arranged as near as possible to joints and changes in direction. The spacing of the supports shall not exceed the centres given in Tables 1 and 2. Where there are two or more sizes of pipes, the common support spacings shall be based on the centres required for the smallest bore pipework.

Vertical rising pipework shall be supported at the base, branches from the riser shall not be used as a means of support for the riser.

Where pipework up to 50mm size is fixed to solid walls, brackets may be of the screw-on or long shank built-in type, except where the walls are plastered, when only the long shank built-in type shall be used. For fixing to woodwork and lightweight partitions or walls they shall be screw on pattern and may be adjustable two piece type. For mild steel pipework, brackets shall be mild steel or malleable iron, brackets for copper pipework shall be brass or gunmetal. The upper part of the clip shall be detachable without disturbing the fixing.

Brackets screwed to walls shall be secured by expanding plugs or other purpose designed fixing devices. Soft wood plugs shall not be permitted.

Pipework in ducts and voids subjected to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed with the Contract Administrator. It is expressly forbidden for mains or potable cold water pipework to be installed in a common trench or duct alongside hot water or heating pipework, no matter what standard of thermal insulation is fitted.

Hangers from horizontal pipework at high level shall be supported from angles or channel irons, suitable for building in or otherwise securing to the structure. Adjustable mild steel hangers shall be used. Pipe rings shall be of malleable cast iron or fabricated steel, made in halves and secured by bolts and screws. Alternatively, malleable iron hinged pipe rings may be used, but calliper hooks will not be permitted.

Where pipework is fitted in ducts or trenches, and it is of 65mm size or greater and supported from the walls, the design of the pipe support, guides and anchors shall be as indicated, and of an approved type. The preformed insulation shall be kept free of the rolling surface and when in external ducts or trenches insulation shall comply with Clause 9-8. Load bearing insulation at supports, where required, shall be fitted by the contractor at the time of erecting the pipework. Where a pipe dips under a door into a floor chase, the pipe shall be formed/pulled in a single length and shall contain no joints or fittings

On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be provided, and shall be welded to the pipework. Where it is impracticable to weld the anchors to the pipework, cast iron chairs with at least 2 wrought iron stirrup bolts shall be used, the bolts shall be provided with sufficient thread to ensure an effective grip on the pipe. For copper pipework the anchors shall be provided by wide upper straps secured to the pipework in such a manner that the pipe is not damaged. The Contractor shall supply and fix in position ready for building in all cleats (and steelwork) required for anchor points. Anchor steelwork secured to the bottom of ducts or trenches shall be coated with hot poured bitumen.

Provision for movement due to expansion and contraction shall be made by changes in direction of the pipework by loops or by special expansion joints approved by the Contract Administrator. Supports, steadyers and guides shall be arranged to ensure that all movement is taken up by the change in direction by the pipework loop or joint. Where pipework is required to be pre-stressed for the purpose of reducing expansion stress under working conditions, the extent of the cold pull shall be as indicated.

No anchoring is to be carried out in buildings, neither is any structural steelwork to be cut or welded to, unless clearance is obtained from the Contract Administrator.

4-12 **AIR VENTING**

Devices for air venting shall be provided at all high points in the pipework. They shall be installed at the highest point of the sections which they are intended to vent.

Air bottles for L.T.H.W. systems shall be made from 50mm size tube, each approximately 200mm long fitted with a cap and 8mm size air cock, they shall be fitted to equal tees or have 50mm size connections if the main is 50mm size or above. Where an air bottle is fixed out of reach, an 8mm size extension tube shall be run to a suitable visible position, terminating with an 8mm size needle seated key operated air cock.

Automatic air vents shall be used where necessary, and shall be of Charles Winn manufacture or other equal and approved, with drip pipe taken to discharge in an approved visible location. Spirax Sarco AAVs shall be allowed only where designated by the Contract Administrator. All AAVs shall be fitted with separate isolation i.e. valve fitted between AAV and pipe being vented.

Air venting devices and any air release pipes installed in exposed positions shall be insulated to prevent freezing.

Air eliminators/separators as specified shall be installed on both heating and hot water circulations where called for by the Contract Administrator.

4-13 **EMPTYING DOWN AND DRAINING**

- (a) Cylinders, calorifiers and L.T.H.W. boilers shall be provided at their lowest points with key operated gland cocks having hose unions. Alternatively, the emptying cocks shall be connected into a common drain run visibly to waste.
- (b) key operated cocks with hose unions shall be fitted at all low points of L.T.H.W., D.H.W.S. and cold water systems to ensure drainage, and sized to permit drainage in a reasonable time (not to exceed one hour for calorifiers) and following zone isolating valves.

4-14 **PAINTING PIPEWORK AND FITTINGS**

The Contractor shall wire brush free from rust all black steel pipework, and all fittings and supports and paint with one coat of red oxide paint. When pipework is not to be insulated, an additional coat of gloss paint shall be applied, black within boiler houses and to match existing elsewhere.

Internal pipework exposed in rooms shall be decorated with an additional two coats of paint to match the existing decorations.

Gas pipework shall be painted as described elsewhere.

4-15 **SPRINKLER SYSTEMS**

Refer to project particular specification for sprinkler installations

4-16 **TABLE 1**
SUPPORTS FOR STEEL PIPEWORK

Size:- mm	Intervals Horizontal runs		Intervals Vertical runs
	Bare metres	Lagged metres	Bare or lagged metres
15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.7
50	3.0	2.4	3.7
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	4.0	3.0	4.6
125	4.5	3.7	5.5
150	5.5	4.5	5.5

TABLE 2
SUPPORTS FOR COPPER PIPEWORK

Size:- mm	Intervals Horizontal runs		Intervals Vertical runs
	Bare metres	lagged metres	Bare or lagged metres
15	1.2	1.2	1.8
22	1.2	1.2	1.8
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0
54	2.7	1.8	3.0
76	3.0	2.4	3.7
108	3.0	2.4	3.7

PART 5**CALORIFIERS, CYLINDERS, CISTERNS AND WATER TANKS****5-1 CALORIFIERS**

Storage and non-storage calorifiers shall be installed where indicated on the Schedule of Materials.

Each calorifier shall be provided with:-

- (a) A relief/safety valve
- (b) An altitude or pressure gauge
- (c) A thermometer
- (d) An open vent pipe on system open to atmosphere (except on pressurised systems, which shall incorporate the Manufacturer's proprietary kit of valves and expansion vessel in compliance with the Building Regulations and Pressure Systems safety Regulations)
- (e) Bolted head or manhole for internal inspection and cleaning purposes with gaskets of WRc-listed approved material such as EDPM rubber (NOT natural rubber)
- (f) Thermostatic control or provision for control by BEMS
- (g) A drain cock with hose union
- (h) Non return valves on both cold feed and return connections on HWS storage calorifiers
- (i) In the specific case of large calorifiers and domestic hot water heaters, where specified, there may be a requirement for an anti-stratification pump. Such pumps shall be bronze, suitable for HWS duty and connected between HWS flow and cold feed or drain. Pumps shall be controlled to run for one hour per day only during a period of no HWS demand but while the heat source is available.
- (j) Insulated casing, as detailed under Clause 10-3
- (k) Flanges or unions on all connections for easy disconnection

Horizontal calorifiers shall be supported on brick or concrete piers, and/or mild steel cradles. Sheet lead pads shall be fitted on the bearing surfaces of copper calorifiers. Vertical calorifiers shall have convex bottoms and shall be fitted with feet and a purpose-made steel support frame.

Where existing calorifiers are to be re-used the Contractor shall provide all items as Clause 5-1(a-k) where not already fitted.

Tundishes installed in connection with unvented hot water systems shall be of the 'one-piece' semi-enclosed pattern having inlet and outlet connections cast or fabricated as part of a single assembly. Open, two piece proprietary tundishes or tundishes made up from separate fittings will not be accepted.

5-2 CYLINDERS

The Contractor shall supply cylinders where indicated on the Specification.

Each cylinder shall be provided with all items as specified for calorifiers under Clause 5-1(a to k)

Horizontal cylinders shall be supported as recommended by the manufacturer.

Vertical cylinders shall be supported with a frame supplied by the manufacturers or from a raised plinth, as instructed by the Contract Administrator.

Manhole covers shall be secured with studs and nuts or with one or more external bridge.

Joints for manhole and manhole covers shall be made with approved jointing material.

Where existing cylinders are to be re-used the Contractor shall provide all items as Clause 5-1 (a-k) where not already fitted.

5-3 CISTERNS AND COLD WATER TANKS

Cisterns and tanks shall be as indicated on the Specification.

Each cistern or tank shall be fitted with a float operated valve in accordance with the relevant Regulation to BS 1212 Part 2 (Diaphragm Type with Brass body of Aylesbury type), capable of withstanding backsiphonage when the water level is at the centre line of the valve.

Connections to float operated valves to be installed in accordance with Water Supply (Water Fittings) Regulations 1999. Float operated valves shall be of the size indicated, and suitable for the pressure available on the particular site.

All cisterns, cold water storage, hot water feed, and feed and expansion, shall be constructed from one piece top quality polyester resin/glass fibre, with all but the smallest tanks having integral welded steel frames encapsulated with the laminate.

All tanks used for heating feed and expansion shall be fitted with loose lightweight lids which are to be slotted for the passage of vent pipes. It is essential on feed and expansion tanks that the ball valve and overflow are fitted such that there is sufficient capacity in the tank to accept the expansion of the system.

All tanks and cisterns shall be suitable for storing water up to temperatures of 90 degC., and all connections made with unions or flanges for easy disconnection.

All tanks used for potable water supply, ie to both hot and cold water systems shall comply with Water Supply (Water Fittings) Regulations 1999, complete with sealed cover with inspection manhole, and fully insulated to a minimum thickness of 25mm encapsulated within the tank structure.

Overflow pipes shall be twice the bore of the ball valve fitted or 32mm size whichever is the greater. Overflow and warning pipes shall be run to discharge visibly outside the building (not over flat roofs), and shall be fitted with a screen to protect from ingress of birds, insects and rodents. Open vents for domestic hot and cold water service tanks shall not be terminated over the tank but discharge visibly outside the building via a tundish or similar air break device.

Cisterns and tanks shall be supported over their whole base area.

All cisterns and tanks shall be installed ensuring suitable access for maintenance purposes. A minimum of 350mm on tanks below 1000 litres, and 500mm on tanks above 1000 litres is to be maintained for access to the ball valve. Walkways constructed from 600mm wide flooring grade chipboard shall also be provided from the tankroom access position to the float valve side of the tank. The location of tanks is to ensure that covers and/or manholes can be easily removed for access for maintenance..

Cisterns, cold water tanks and pipework shall be thoroughly cleaned and then disinfected by the application of chlorine in accordance with BS 6700 1999 Clause 10.1 (page 55), and as detailed in this specification (Part 12) to the satisfaction of the Contract Administrator, before being brought into use for domestic purposes.

F&E Cisterns

Boiler Rating KW (BTU/Hr)	Float Valve mm	Safety Valve mm	Cold Feed mm	Open Vent mm	Over-flow mm	Nominal Cistern Capacity litres
Over 44 (150,000)						
Up to 58 (200,000)	15	20	20	25	32	90
Over 58 (200,000)						
Up to 146 (500,000)	15	20	25	32	32	170
Over 146 (500,000)						
Up to 293 (1,000,000)	20	25	32	40	40	260
Over 293 (1,000,000)						
Up to 586 (2,000,000)	20	32	40	50	50	350
Over 586 (2,000,000)						
Up to 1470 (5,000,000)	25	50	50	65	80	880

PART 6**SPACE HEATING EQUIPMENT****6-1 RADIATORS**

All radiators shall be supplied by the Contractor as indicated on the Specification, and shall be installed in positions as shown on the drawings.

Radiators can be of the steel panel, cast iron, or low surface temperature pattern, and the following details are general to all.

The positions and heights above the floor of all radiators shall be confirmed with Contract Administrator. A minimum clearance of 75mm shall be provided between the floor and the underside of any pipe serving a radiator. The minimum clearance between the floor and the underside of the radiator shall be 150mm. Radiators shall be kept 40mm clear from walls when supporting brackets and stays are built in, otherwise clearance shall be in accordance with manufacturers Standard Details.

All radiators shall be factory finished in the manufacturer's standard white / chromed finish. All radiators shall be provided with valves as indicated in Valve Clause 7-5. An air cock or vent plug shall be fitted to each radiator and be arranged so that the water-ways can be completely evacuated of air when operated. A drain cock shall be provided to enable all of the radiators to be drained. Radiators shall be supported on bottom brackets and top stays or purpose designed brackets to suit the type of radiator, the supports may be of the two piece adjustable pattern.

Where used on masonry walls they may be either built-in or plugged and screwed to the wall face. Where the masonry walls have an internal light-weight structural surface, the radiator support shall pass through the facing and be built into the load bearing wall.

Supports for all radiators may be fixed direct to light-weight partitions but only where these extend from floor to ceiling. Supports for radiators against light-weight partitions shall be designed to transmit the weight to the floor and shall be screwed to or built into the floor, top stays may be screwed to the partition. Where radiators are fed by a straight section of pipework which is beneath the radiators and is more than 10m long, the radiator brackets shall be of the suspended pattern or other approved type designed to permit free movement due to expansion and contraction of the pipework. (Pipe sets of under 225mm shall be deemed straight pipework). When supporting radiators fixed to light-weight partitions, each bracket shall be screwed on to a vertical strut of not less than 50mm x 6mm thick mild steel flat, arranged to transmit the weight to the floor, the bottom of the strut shall be fixed to the floor.

The number of brackets and/or wall stays per radiator shall be as specified by the manufacturer. Where radiators with feet are specified and the floor finish is of a material likely to be damaged, the radiator shall stand on 12mm thick hard wood boards supplied by the Contractor. The Contractor shall include for taking down radiators as required for painting, and refixing.

Where existing radiators are to be re-used, they are to be disconnected and refixed in the same or new position and be thoroughly washed out, wire brushed and repainted as necessary using a propriety radiator paint.

6-2 NATURAL CONVECTORS

Natural convectors shall be of the types, ratings and dimensions as indicated either on the drawing, or in the Schedule of Materials.

The positions and heights above the floor of convectors shall be agreed with the Contract Administrator. Where recessed or built-in convectors have been specified, the Contractor shall supply details of the openings and of any fixings or framing required before commencement of work.

All wall mounted convectors shall be secured to the walls as recommended by the manufacturers or as indicated on the Drawing.

Wall convectors shall be provided with air cocks accessible from the front or side without dismantling the casing. Flow and return connections shall be provided, with valves, as indicated in Clause 7-4.

6-3 **FAN CONVECTORS**

The Contractor shall supply convectors of the types and ratings and dimensions as indicated on the drawing or in the Schedule of Materials.

All fan convectors shall be fitted with operating thermostats and hold off thermostats as detailed in the Specification, or as supplied with the fan convector.

Each fan convector shall be fitted with isolating gate valves as described in the Clause 7-4 and shall incorporate a manual air vent with loose key or a drain cock, and applicable all to be easily accessible for maintenance.

All fan convectors shall be fitted with a suitable washable air filter, which shall be accessible for cleaning. Where existing fan convectors are to be re-used the Contractor shall include for cleaning and/or replacing the filters as found necessary, and for checking that the existing thermostats are operational.

Where dual speed fan convectors are specified with room and speed changeover thermostats, the Contractor must ensure that the sequence of operation is correct.

6-4 **RADIANT PANELS, STRIPS AND CEILINGS**

Radiant Panels, strips and ceilings shall be of the ratings and dimensions as indicated on the drawings or in the Schedule of Materials. Radiant panels shall be pre-insulated by the manufacturer and factory finished in a colour to the architects requirements.

All surface plates shall be smooth and free from distortion. Where connections pass through the side of a panel, they shall be sealed effectively. The spaces between the edges of the panel and the wall or ceiling surface to which the panel is to be attached, shall be completely sealed.

Each radiant strip shall be assembled in a continuous unbroken length.

Radiant panels and strips shall be arranged horizontally, vertically or inclined as indicated on the drawings and suspended from purpose designed hangers, the points of support being in accordance with the maker's recommendations. All panels and strips shall be fitted with valves as described in Part 7.

6-5 **UNIT HEATERS**

The Contractor shall supply and install unit heaters sizes and ratings as indicated on drawings or Schedule of Materials.

Each motor shall be supplied with a starter and isolator. The type of method of automatic control of the unit heaters shall be as indicated. Heaters shall be provided with two or more points of suspension and shall be so suspended that their direction of discharge can be altered. All unit heaters shall be fitted with isolating gate valves as described in Part 7.

Hold off thermostats shall be supplied and installed where not supplied with the heater.

PART 7

VALVES, TAPS AND COCKS

7-1 SUPPLY

The Contractor shall supply valves, taps and cocks of the following manufacture, sizes of which shall be as stated on the drawings or Schedule of Materials.

7-2 SAFETY VALVES OR RELIEF VALVES

Nabic spring safety valves (screwed), to be set to lift at the system static head + 0.5 bar minimum.

Each safety valve shall be fitted with a drip pipe of suitable size terminating within 300mm of the Boiler House floor.

7-3 VALVES GENERAL

Notwithstanding the below all valves selected shall be suitable for their application and all valves in domestic water services systems shall be WRC approved.

Isolating valves up to 50mm dia (PN20 Series B): (refer elsewhere to valves for specific applications)

Crane Fig. No. D151 wheel head to flows.
Crane Fig. No. D.237 lockshield heads to returns.
Hattersley Fig. No. D.33X wheel head to flows.
Hattersley Fig. No. D.33XLS lockshield to returns.
Hattersley Fig. 113 ball valve for heating distribution systems (not within plantrooms)
Hattersley fig. 105 ball valve for DWS distribution systems (not within plantrooms)

Isolating valves 65mm dia. and above (PN6 flanged):

Crane Fig.No. F52.
Hattersley Fig. No.M549.

Commissioning sets:

50mm and below: Crane Fig. No. D 941 (PN20)
Hattersley Fig. No. 1732
Taconova Setter Bypass SD where specified
65mm and above: Crane Fig. No. DM 940 (PN16 flanged)
Hattersley Fig. No. M 737 (PN16 flanged)
Taconova Setter Bypass Flange where specified

Double Regulating Valves:

50mm and below: Crane Fig. D920 (PN20)
Hattersley Fig. 1432 (PN20)
65mm and above: Crane Fig. DM920 (PN16 flanged)
Hattersley Fig. M733DR (PN16 flanged)

Non Return/Check valves up to 50mm Dia:

Hattersley Fig. No. 47.PN 25 series B bronze swing pattern.
Holden and Brooke 'senflux' pattern (Horizontal only)
Gestra Fig No. MB.14

Non Return/Check valves 65mm and above:

Hattersley Fig. No. M651 PN6 cast iron swing.
Holden and Brooke 'senflux' pattern (Horizontal only).

7-6 DRAIN COCKS

Drain cocks shall be provided in locations as described elsewhere.

Exposed locations:

Crane Fig No. D340
Hattersley Fig. No.371 and 81HU in Boiler Rooms.

Boiler and Plant Rooms and Ducts etc:

Crane Fig No. D342HU
Hattersley Fig No. 81HU

7-7 GAS COCKS / VALVES

General plant / section isolation valves up to 80mm:

Crane Fig. No. 191 Ball type
Hattersley Fig. No. 100 Ball type.

General plant / section isolation valves 100mm and above:

Crane Fig No.F611
Audco 'Slim seal'

Emergency control valves up to 50mm:

Crane Fig. No. 191 Ball type
Hattersley Fig. No. 100 Ball type.

Emergency control valves 65mm and above:

Donkin Fig 555 with position indicator

All valves shall be supplied with a hand lever, and Contractor to specify to supplier for USE ON GAS.

Gas valve on LPG services (Propane or Butane) to be 'Saunders' diaphragm valves - special version with type 'C' neoprene diaphragm with 'out of doors' weather protection finish by the manufacturer.

7-8 D.H.W.S. (SECONDARIES AND TANK COLD WATER SYSTEMS)

Exposed valves on 15mm and 22mm hot and tank cold water supplies to basins etc. to be full-bore pattern 'Ballofix' CP valves by Cotham and Preedy (no other manufacturer is acceptable)

Valves up to 50mm Dia.:

Crane Fig. No. D151 wheel or lockshield with adapters.
Hattersley Fig. No. 33X wheel head with adapters.
Yorkshire 610 or 610LS.

Valves 65mm Dia. and above:

Hattersley Fig. No. 35. PN16

Thermostatic Mixing Valves and Shower Fittings:

Shall be as specified. Where not specified wash basins shall be provided with Reliance water controls 4 in 1 TMV3 valves for 15mm applications and Reliance Promix 22mm TMV3 valves for 22mm applications.

7-9 **MAINS COLD WATER**

All stop cocks to be Yorkshire 501 GM or 501 GMLS.

All stop cocks on underground services to be EBCO to BS 5433

7-10 **LABELLING OF VALVES**

All Boiler Room valves and every circuit control valve shall be provided with an ivorine/traffolyte or approved plastic label 40mm in diameter and stamped or engraved with a reference number. Wherever practicable the label shall be fixed up to the valve(s) in a prominent position to identify the valve concerned. Elsewhere, purpose-made light-weight steel brackets for carrying the labels shall be welded to the pipework adjacent to the valves.

The Contractor shall provide and fix an encapsulated plastic drawing in a position to be indicated by the Supervising Officer on site, showing the diagrammatic arrangement of the Boiler Room indicating the location of valves, their numbers and function, which should be approved by the Supervising Officer before fixing.

7-11 **POWER SEAT AND CONTROL VALVES**

All power seat valve, control valves etc. shall be as detailed Specification, and the following:

Gas safety 'shut off' valves shall be as detailed in Clause 2-15, and be one of the following 240 volt quick acting valves:

Black Teknigas
Johnson (Maclaren) - GS2000 screwed, GH5000 flanged.
Krome Schroder - VG series.

Three port mixing and diverting valves, and other control valves shall be installed in the pipework in the correct configuration and in accordance with the manufacturer's recommendations. The preferred unit is a shoe type valve which can be ported on site:

Sauter Fig. No. MH32 R/F screwed or flanged as required with either AR30W13F001 (240 volt) or AR30W13F008 (24 volt) actuator having a 110 sec running time, or AR30W32SF001 for an analogue output of 0 to 10 volts as the Specification.

All motorised valves must be fixed such that the motor can be easily accessible and removable for maintenance purposes and cannot be damaged by leaking fluid from glands or seals.

7-12 **PAINTING VALVES**

The Contractor shall allow for painting all new exposed valves, one coat of black gloss paint; existing valves being re-used to be wire brushed clean, painted one coat red oxide paint and one coat black gloss finish. The painting is to include the mating flanges and 50mm of pipe either side which could still be exposed after the application of the insulation.

All valve handles to be painted one coat Red Gloss. The gland nuts and valve spindle are **NOT** to be painted, but must be greased for service requirements.

PART 8

AUTOMATIC CONTROL SYSTEMS

STAND-ALONE AND FULL BUILDING ENERGY MANAGEMENT SYSTEMS - PERFORMANCE AND FUNCTIONALITY SPECIFICATIONS

SPECIFICATIONS FOR ELECTRICAL WIRING AND MECHANICAL SERVICES CONTROL PANELS

Throughout this document, the terms "BMS" and "BEMS" are synonymous, and shall be interpreted as referring to the remotely-controlled Building Energy Management System network and its component parts, owned and operated by Worcestershire County Council and/or its successor Authorities.

8-1 STAND-ALONE CONTROL SYSTEM PERFORMANCE SPECIFICATION

(a) General

A stand alone control system shall be provided for all small HVAC systems of limited complexity and which do not warrant being connected to the County's Building Management System network.

The control system shall be based on the Trend Control Systems Xcite expandable system, incorporating an IQ3x-series programmable HVAC controllers complete with integral broadband, web browser, user-operable keyboard and display unit. The ADL software functionality is identical to the Trend full BEMS package with the exception of alarm reporting to the central station and 2nd stage frost protection. In addition, the input/output count is necessarily restricted. The Trend controller shall provide a minimum of 6 inputs and 6 outputs, for configuration as required by the HVAC system being controlled.

There are 4 variants which are now accepted as standard-type systems for use on Worcestershire County Council stand-alone HVAC schemes. These are all based on the "WCC TREND IQ22x ADL v1.0" software functionality specification, jointly developed by Worcestershire County Council and Trend Services Limited as detailed below.

Only approved control strategies as listed below shall be used. For any other control configuration requirements the designer shall agree these with Worcestershire County Council's Principal Engineer (Energy) or his representative. On no account will any other control regimes be accepted by the Authority unless prior approval has been agreed.

(b) Electrical Installation

All as detailed in part 8-3

(c) Control Panel

A purpose built control panel as detailed in part 8-4 shall be provided to house all of the motor control components and Trend Controllers.

(d) Controllers/control equipment

The designer shall specify all of the controllers, sensors, thermostats, emergency/safety buttons, links, and any other control equipment required to complete the scheme. A schedule for the control equipment shall be required to form part of the specification.

WCC STANDARD CONTROL STRATEGY

IQ22x ADL v1.0

Type 1

Basic LTHW heating/HVAC System with DHWS

2 Heating Boilers
1 VT circuit
Boiler Shunt pumps
Electric DHW Services

Boiler Control

The 2 heating boilers shall be enabled whenever there is a demand. The duty boiler shall change on a daily basis. The boilers shall be shed according to the criteria below.

Boiler Shedding

Provided that during occupancy the space temperature in the heating zone has attained its occupancy setpoint and the VT valve output signal is below 90%, then boiler shedding based on outside air temperature shall take place as follows.

- (a). Should the outside air temperature exceed the set value of the (boiler shedding OAT SPT) variable, then the lag boiler shall be shed.
- b). Should the outside air temperature exceed the added values of (boiler shedding OAT SPT) and (boiler shedding diff value) then the lead boiler shall also be shed.

Shunt Pumps

The shunt pumps shall be enabled whenever there is a heating demand, and under frost protection conditions. The pumps shall overrun for a time of 15 minutes at the end of demand to allow for heat dissipation.

Space VT Heating Control

The space heating zone shall have optimum stop/start (OSS) facility via optimiser 1, and shall be under the dictates of Time Zone 1. The space temperature shall be monitored by one suitably-located room sensor which shall provide information for optimisation and 3rd stage frost protection. Should the heating zone not optimise 'on' for a period exceeding 24 hrs, for example weekend or holiday shutdown, then the OSS occupancy setpoint shall automatically be increased by 2°C to provide an earlier than normal OSS start for the next occupancy period, subject to the maximum preheat period as set in the optimiser. The VT valve shall be modulated to provide control to a compensated flow setpoint, according to outside air temperature. The compensated flow temperature setpoint shall be set to maximum during warm up, 3rd stage frost, and plant extend periods (whilst the space temp is below occupancy setpoint). Room trim of the calculated VT flow shall be provided. The VT valve shall open fully during periods of no demand, and at end of shift, as VT pumps are commanded to overrun based on VT flow temperature, as well as a timed overrun of 15 minutes to allow for heat dissipation.

DHWS - Fixed Time Control

The DHWS services are enabled according to the times as set in Time Zone 2.

Common Plant Extension Facility

Timed plant extension is provided to extend the heating and DHWS for a fixed period. The actual fixed heating extension period is adjustable by the (common extension time) variable, and is invoked by operating a keyswitch on the control panel. When the heating extension is applied, the heating and DHWS shall be extended for the specified time immediately. Once the heating/DHWS has been extended, it can be terminated early if required by again by reapplying the extension key-switch. The software switch acts in the same way as a pushbutton, i.e. first operation toggles the extension on and next operation toggles the extension off. The software switch is self re-setting, and shall always return to zero after the time has elapsed.

Frost Protection

There are two levels of frost protection provided for the plant and fabric of the building, stage 1 and stage 3.

1st Stage Frost Protection - pumps

1st stage frost protection activates when the outside air temperature falls below the set value, normally 1°C; once activated the heating pumps and shunt pumps shall be enabled, the operation shall terminate when outside air temperature rises to 2°C above this setpoint.

2nd Stage Frost Protection – return water sensing

Not provided within the ADL system functionality.

3rd Stage Frost Protection - space

3rd stage frost protection activates when the minimum space temp in the heating zone falls below the setpoint; once activated the heating boiler(s) and all pumps shall be enabled, the differential above this setpoint is determined by the setting for fan convector or radiator sites. Set to zero for radiators (2°C differential), set to one for fan convectors (5°C differential).

Optimisation Cool-down Limitation

Limitation of the optimiser maximum cool down time period is provided, as a function of outside air temperature. The maximum cool down period in relation to outside air temperature is as follows.

Outside Air Temperature	Max Cool down Period (Minutes)	
	F/Cs	Rads
<0°C	30	60
0-5°C	45	90
5-10°C	75	120
10-14°C	90	180
>14°C	180	300

Please note - The software switch in the outstation should be set dependent on whether the site is served by radiators or fan convectors. Set to zero for radiators, set to one for fan convectors. The respective values above will then be used by the ADL software in the cool down limitation calculations.

IQ3X Controller Standard Point Schedule**Input Channels**

1	I/P C	OUTSIDE AIR TEMP S1
2	I/P C	SPACE TEMP S2
3	I/P C	VT HEATING FLOW S3
4	I/P C	PLANT EXTEND MOMENTARY KEYSWITCH
5	I/P C	SUMMER/WINTER/HOLIDAY/MANUAL SWITCH INPUT 1
6	I/P C	SUMMER/WINTER/HOLIDAY/MANUAL SWITCH INPUT 2

Status monitoring of summer/winter/holiday keyswitch on the control panel fascia is via digital inputs 5 and 6.

The following binary combinations are required:

SWITCH SETTING	DI 5 STATUS	DI 6 STATUS
SUMMER	0	0
WINTER	0	1
HOLIDAY	1	0
MANUAL OVERRIDE	1	1

Output Channels

1	O/P C	BOILER 1 ENABLE
2	O/P C	BOILER 2 ENABLE
3	O/P C	SHUNT PUMPS ENABLE
4	O/P C	VT PUMPS ENABLE
5	O/P C	VT VALVE ACTUATOR POSITION 0-10v OUTPUT
6	O/P C	ELECTRIC DHWS or DHWS HOTWATER GENERATOR OUTPUT

Default Program Settings

Adjustable via the controller keypad

- 1) Set switch 20 depending on whether the site is served by radiators (set to off) or fan convectors (set to on)

The default setting is zero (off)

- 2) Set the minimum VT (knob 8) and maximum VT (knob 9) flow setpoints.

Default settings are 80°C for VT max, 30°C for VT min.

	max VT flow	min VT flow
For radiator site	80°C	30°C
For fan convector site	80°C	65°C

- 3) Set the space occupancy setpoint as required.

The default setting is 20°C.

- 4) Check and set as necessary the time, date and daylight saving times in the outstation.

- 5) Change time zone times if necessary.

The default times for zone 1 (Heating occupancy times) are Mon - Fri 08.30 to 15.30. The default times for zone 2 (DHWS times) are Mon - Fri 08.00 to 16.00

VARIANTS TO WCC STANDARD CONTROL STRATEGY

Additional standard control arrangements have been devised to cater for other types of boilers, pumps and heat emitters when employing Trend ADL controllers. These are designated Type 2A, Type 3A and Type 4A respectively and shall be selected to suit the specified mechanical plant, as detailed below.

Standard Software Versions

IQ3X ADL v2.0

TYPE-2A

System description

Boilers

2no. condensing boilers.

VT zone

Variable weather dependent flow temperature control, achieved via direct modulation of the condensing boilers' flow temperature.

DHWS

Single output for electric DHWS or DHWS Hot water generator.

IQ3X ADL v3.0

TYPE-3A

System description

Boilers

3no. condensing boilers.

VT zone

Variable weather dependent flow temperature control, achieved via direct modulation of the condensing boilers' flow temperature.

DHWS

Single output for electric DHWS or DHWS Hot water generator.

IQ3X ADL v4.0

TYPE-4A

System description

Boilers

2 conventional high efficiency boilers, common shunt pump enable.

CT zone

Constant temperature control of the CT heating flow via the sequencing of boilers.

DHWS

Single output for electric DHWS or DHWS Hot water generator.

All technical enquiries to

Trend Services
Central Division
PO Box 34
Horsham
West Sussex
RH12 2YF
Tel 01403 226931

Quote Reference, Trend ADL Standard Projects Worcestershire County Council.

8-2 FULL BEMS CONTROL SYSTEM PERFORMANCE SPECIFICATION

(a) Procurement of Building Energy Management Systems

A full BEMS control system shall be provided for all medium and large HVAC systems of average to high complexity and which warrant being connected to the County's Building Management System network.

The BMS control system shall be supplied and engineered from one of the manufacturers listed below. On no account shall any other system, systems house or agent be used.

Trend Control Systems '963' BEMS system

Supplied only from:

Trend Control Systems Ltd
Central Division
PO Box 34
Horsham
West Sussex
RH12 2YF
Tel 01403 226600
Fax 01403 265540

All initial enquiries shall be made to the area sales team for the Central region, stating that the enquiry relates to a Worcestershire County Council project.

OR

Tour Andover Controls (TAC) 'Continuum' BEMS system

Supplied only from:

TAC.UK
Midlands Division (EUP5)
Smisby Road
Ashby-de-la-Zouch
Leicestershire
LE65 2UG
Tel 01530 417733
Fax 01530

All initial enquiries shall be made to the area sales team for the Midlands Division (EUP5), stating that the enquiry relates to a Worcestershire County Council project.

The control system designer shall also refer to Worcestershire County Council's "Guidance Notes for Designers of Electrical and Mechanical Engineering Installations" for equipment selection, preferred manufacturers and specific monitoring functionality.

(b) BEMS control and monitoring points

To provide adequate control and monitoring functionality the design of the HVAC control system shall incorporate where appropriate the control and monitoring points listed on the following pages. The points listed shall be used to build up the minimum requirements of the system, but shall not be considered exhaustive; the designer will consider and include any other points which may be advantageous to the operation and monitoring of the building.

	AO	AI	DO	DI
Heating Boilers				
Boiler Enable			✓	
Burner Modulation	✓			
Common Boiler fault				✓
Boiler High Limit Temperature Cut-out				✓
Burner lockout				✓
Burner isolated				✓
<u>Note</u> , where boilers are supplied with only a common fault signal, the High Limit and lockout alarm will be substituted for a single, Boiler Fault Alarm.				✓
Boiler Primary / Shunt Pumps				
Pump Enable			✓	
Pump Speed Control via External Inverter Drive	✓			
Pump Isolated / Starter Overload Tripped				✓
Flow monitoring and Fault alarm, (Current Transformer)		✓		
Flow failure Lamp			✓	
Heating Pumps				
Pump Enable			✓	
Pump Speed Control via External Inverter Drive	✓			
Pump Isolated / Starter Overload Tripped				✓
Flow monitoring and Fault alarm, (Current Transformer)		✓		
Flow failure Lamp			✓	
Control Valves				
Valve, Modulating Control, 24v ac, 0-10v dc.	✓			
Valve, On/Off Control, 24v Switched			✓	
Valve Isolated/MCB Tripped				✓
Domestic Hot Water Boilers				
Boiler Enable			✓	
Common Boiler fault				✓
Boiler High Limit Temperature Cut-out				✓
Burner lockout				✓
Burner isolated				✓
<u>Note</u> , where boilers are supplied with only a common fault signal, the High Limit and lockout alarm will be substituted for a single, Boiler Fault Alarm.				
Domestic Hot Water Secondary Pumps				
Pump Enable			✓	

Pump Isolated / Starter Overload Tripped				<u>✓</u>
Flow monitoring and Fault alarm, (Current Transformer)		<u>✓</u>		
Flow failure Lamp			<u>✓</u>	
Ventilation Systems				
Supply Fans				
Fan Enable			<u>✓</u>	
Fan Speed Control via External Inverter Drive	<u>✓</u>			
Fan Isolated / Starter Overload Tripped				<u>✓</u>
Flow monitoring and Fault alarm, (Current Transformer)		<u>✓</u>		
Flow failure Lamp			<u>✓</u>	
	AO	AI	DO	DI
Extract Fans				
Fan Enable			<u>✓</u>	
Fan Speed Control via External Inverter Drive	<u>✓</u>			
Fan Isolated / Starter Overload Tripped				<u>✓</u>
Flow monitoring and Fault alarm, (Current Transformer)		<u>✓</u>		
Flow failure Lamp			<u>✓</u>	
Dampers				
Damper, Modulating Control, 24v ac, 0-10v dc.	<u>✓</u>			
Damper, On/Off Control, 24v Switched			<u>✓</u>	
Damper Isolated				<u>✓</u>
Site Local Control				
Extension Override Key-switch				<u>✓</u>
Maintenance/Manual Key-switch, (to be provided on every control panel)				<u>✓</u>
Common Alarm lamp			<u>✓</u>	
Extension Override Lamp			<u>✓</u>	
Extension Binary Thumb-wheel,				<u>✓(x4)</u>
Miscellaneous Points				
Fire/power/gas alarm				<u>✓</u>
Control circuit MCB Tripped				<u>✓</u>
Transformer Primary/secondary MCB Tripped				<u>✓</u>

(c) Electrical Installation

All as detailed in part 8-3.

Whilst it is common practice for the electrical installation associated with the mechanical engineering plant (frequently termed “the field wiring”) to be carried out by the Electrical Sub-Contractor, it is emphasised that specific requirements over and above the current IEE Regulations apply to electrical wiring in boilerhouses and plant rooms and for control systems, particularly in respect of colour coding, cable identification, cable and insulation type, containment, testing and commissioning. This section of the work remains the responsibility of the Mechanical Sub-Contractor and shall be effectively and properly co-ordinated by the Main Contractor to prevent delays in acceptance and handover of the controls installations.

(d) Control Panel

A purpose built compartmentalised control panel, as detailed in part 8-4, shall be provided to house all of the motor control components and control manufacturers' equipment.

(e) Controllers/control equipment

The designer shall specify all of the controllers, sensors, thermostats, emergency/safety buttons, links, and any other control equipment required to complete the scheme. A schedule for the control equipment shall be required to form part of the specification.

Worcestershire County Council policy is that the BEMS control hardware, software and design shall be procured either directly from one of the two currently-approved controls manufacturers. The two approved manufacturers are

Trend Control Systems Ltd
Tour Andover Controls Ltd

Contact details can be found elsewhere within the specification.

WCC STANDARD CONTROL STRATEGY**(f) Points strategy and configuration**

Only approved control strategies shall be used. For any other control configuration requirements the designer shall agree these with Worcestershire County Council's Principal Engineer (Energy) or his representative. On no account will any other control regimes be accepted by the Authority unless prior approval has been obtained.

Digital outputs, controlling heating services and systems which are critical to maintaining the building and building services shall be configured to fail safe (on), wired to the normally closed contacts of each output and comply with the statement:

normally closed contact, relay de-energised = system “on”

Analogue outputs, 0-10volt control signals, used in the control of valves for heating services shall be configured to fail safe (on), and comply with the statement:

0 volts = system “on”

Where analogue outputs are used in the control of other items of equipment, such as boilers, variable speed drives etc. where due to the limitations of the equipment the facility to provide control in this manner the designer shall ensure that the building and building services are not put at risk in the event of any controls failure.

Digital inputs, all digital inputs shall be configured to comply with the statement:

1 = healthy

0 = fault

Analogue inputs, such as thermistor devices, position feedback potentiometers, current transformers, pressure transducers etc. shall be configured such that the control system fails safe in the event of an open- or short-circuit at the input terminals.

Control Point Default Settings

ANALOGUE INPUTS		ALARM REPORTING	ALARM REPORTING DURING ON TIMES	ALARM REPORTING DURING OFF TIMES	
Outside Air Temperature sensors.		Outside of Limits <u>ANY Time</u> EVERY Time			
Room Temperature sensors.		Outside of Limits <u>ANY Time</u> EVERY Time	30mins after occupancy time, set point -5deg not reached.	30mins after fixed low value of 6degC is reached.	
Flow Temperature sensors		Outside of Limits <u>ANY Time</u> EVERY Time			
DHWS Flow and Return Temperature sensors		Outside of Limits <u>ANY Time</u> EVERY Time	60mins after start time, set point -5degC not reached.		
Tanked Cold Water		Outside of Limits and above set point <u>ANY Time</u> EVERY Time			
Mains Cold Water		Outside of Limits and above set point <u>ANY Time</u> EVERY Time			
Motor running current		Outside of Limits <u>ANY Time</u> EVERY Time			
DIGITAL INPUTS					
All digital inputs		<u>ANY Time</u> EVERY Time			

CONTROL OUTPUTS		TIME PROGRAMM	ANALOGUE OVERRIDE.	DIGITAL OVERRIDE.	OTHER COMMENTS
Heating Boilers		OSS with shedding with 2 nd and 3 rd level frost protection.			
Shunt Pumps.		OSS with shedding with 2 nd and 3 rd level frost protection	Override <u>ON</u> anytime <u>Above</u> set point 25 – 65degC		Timed Override 15min After the end of time programme
Primary Heating Pumps.		OSS with 1 st 2 nd and 3 rd level frost protection.	Override <u>ON</u> anytime <u>Above</u> set point 25 – 65degC		Timed Override 15min After the end of time programme.
Heating Pumps.		OSS with 1 st 2 nd and 3 rd level frost protection.	Override <u>ON</u> anytime <u>Above</u> set point 25 – 65degC		Timed Override 15min After the end of time programme.
VT Heating Circuit control valve, Mixing configuration		OSS with 3 rd level frost protection.			Boost to terminate at set point -1degC
CT Heating Circuit control valve, Mixing configuration		OSS with 3 rd level frost protection.			Boost to terminate at set point -1degC
Ventilation services, Heating		OSFS with 3 rd level frost protection.			Boost to terminate at set point -1degC
Ventilation services, Tempered Air		OSFS with 3 rd level frost protection.			Boost to terminate at set point -1degC
Heater Battery Control valves		OSFS with 3 rd level frost protection.			Boost to terminate at set point -1degC
DHWS Gas Water Heater.		Fixed Time Start Fixed Stop.	Override off during on times above set point		
DHWS Secondary Pumps.		Fixed Time Start Fixed Stop.	Override <u>ON</u> anytime <u>Above</u> set point 25 – 65degC		Timed Override 10min After the end of time programme.

TIME SCHEDULES					
SCHEDULE		FIXED TIME START / STOP	OPTIMUM START OPTIMUM STOP	OPTIMUM START FIXED STOP	
1	Heating Services.		✓		
2	Heating AHU, recirculating		✓		
3	Heating AHU, fresh air ventilation			✓	
4	Ventilation and Tempered Air Systems	✓			
5	Domestic Hot Water Systems	✓			
6	Bio-mass Boiler Systems	✓			
7					
8					
9					
10					

SET POINTS AND DIFFERENTIALS °C				
TYPE	SET POINT	SET POINT RANGE		
Heating Circuits OSS	19	5-35	OPTIMISER	
Control Valves		0-90	COMPENSATOR	
			DIFFERENTIAL ABOVE SET POINT	DIFFERENTIAL BELOW SET POINT
Heating Pump Overrun	35	25-75		Timed Hysteresis
Boiler Primary Pumps Overrun	35	25-75		Timed Hysteresis
1 st Stage Frost	1	0-10	2	
2 nd Stage Frost	10	0-40	10	
3 rd Stage Frost	8	5-35	2	
Boiler Shedding Start	7	-10 to +20		
Boiler Shedding Differential	7	-10 to +20		
Pump/fan flow monitoring (amps)	Motor speed set FLC	-25% - +25%		

GENERAL DESCRIPTION OF CONTROL PHILOSOPHY

Boiler Control

The heating boilers shall be enabled whenever there is a demand. The duty boiler shall change on a daily basis.

Where specified, the BEMS software shall control the boiler outlet temperature via a 0-10 volt signal to provide temperature compensation directly at the boiler to reduce standing losses and improve efficiency. Provision shall be included for minimum temperature back-end protection where necessary. Hard-wired alarms shall be generated in the event of boiler lock-out and high temperature.

Where the specified boiler plant does not have facilities for 0-10 volt control signals, or has its own manufacturer's controls with restricted BEMS interface capabilities, the minimum BEMS control functionality shall include enable-disable commands and a hard-wired common alarm. Enable-disable command shall operate independently of the mains power contactor/overload supplying the boiler plant, which shall isolate the power to the plant in the event of fire alarm, gas alarm or other external safety event triggering the control circuit.

Boiler firing shall be inhibited in the event of high or low system pressure, low gas pressure, back-end valve closed or primary loop water flow failure.

The boilers shall be shed (i.e. taken off line) according to the criteria below.

Boiler Shedding

Provided that during occupancy the space temperature in the heating zone has attained its occupancy set-point and the VT valve output signal is below 90%, then boiler shedding based on outside air temperature shall take place as follows.

(a) Should the outside air temperature exceed the set value of the (boiler shedding OAT SPT) variable, then the lag boilers shall be shed in sequence.

(b) Should the outside air temperature exceed the added values of (boiler shedding OAT SPT) and (boiler shedding diff value) setpoints, then the lead boiler shall also be shed.

Shunt Pumps

The shunt pumps shall be enabled whenever there is a heating demand, and under frost protection conditions. The pumps shall overrun for a time of 15 minutes at the end of demand to allow for heat dissipation. Provision shall be included to prevent the boilers from firing in the event of primary water flow failure.

Space VT Heating Control

Each space heating zone shall have optimum stop/start (OSS) facility and shall be under the dictates of a dedicated or grouped Time Zone controller. The space temperature shall be monitored by suitably-located room sensors which shall provide information for optimisation, and 3rd stage frost protection. Should any heating zone not optimise 'on' for a period exceeding 24 hrs, for example weekend or holiday shutdown, then the OSS occupancy setpoint shall automatically be increased by 2°C to provide an earlier than normal OSS start for the next occupancy period, subject to the maximum preheat period as set in the optimiser.

The VT valve shall be modulated to provide control to a compensated flow setpoint to each zone, according to outside air temperature. The compensated flow temperature setpoint shall be set to maximum during warm up, 3rd stage frost, and plant extend periods (whilst the space temperature is below occupancy setpoint). Room trim of the calculated VT flow shall be provided. The VT valve shall open fully during periods of no demand, and at end of shift, as VT pumps are commanded to overrun based on VT flow temperature, as well as a timed overrun of 15 minutes to allow for heat dissipation.

Standard wiring arrangements

Worcestershire County Council has a number of approved, standard wiring arrangements for the control and fault monitoring of single and twin set heating pumps. These are available on request from the Principal Engineer (Energy) and shall be incorporated in the system provided.

Space heating, AHU CT circuits

All CT circuits shall be fitted with three-port valves and controlled by temperature compensation software. Normally these circuits will be commissioned to operate on a flatter compensation curve than VT circuits, and the provision for adjustment of the slope shall be included within the supervisor software. The three-port valve also acts as a zone valve during extended operation of other zones, and prevents energy wastage when frost protection is activated.

Pump and fan speed control

Where specified, the BEMS shall directly control pump or fan speed via 0-10 volt signals under the control of the software to match building loads. Where pumps, fans or plant with the manufacturer's integral proprietary speed controllers are specified, care shall be taken to ensure that duty/standby selection, auto-changeover and alarm functions are correctly interfaced with the BEMS.

DHWS - Fixed Time Control

The DHWS services are enabled according to the times as set in one or more dedicated BEMS time schedules.

Common Plant Extension Facility

A manual timed plant extension is provided via a binary code rotary switch to enable the extension of each time schedule for a variable fixed timed period, the extension is invoked by operating a spring-return biased keyswitch on the control panel. When the extension is applied the time schedules shall be extended immediately for the specified time, termination of each extended time schedule will be available by reapplying the extension key-switch, there will be no limitation to the number times the extension can be applied within any 24 hour period. The software switch acts in the same way as a pushbutton, i.e. first operation toggles the extension on and next operation toggles the extension off. The software switch is self re-setting, and shall always return to zero after the time has elapsed.

Manual/Maintenance Override

A manual override shall be provided on each control panel, this is to enable the building user to defeat the control system if desired and for the testing of the system by the County Councils maintenance operatives, without the need for the adjustment of any control loops. The manual override shall be achieved within the software regime of the Building Management System and electrically by overriding the output signals to each item of equipment.

Frost Protection

There are three levels of frost protection provided for the plant and fabric of the building; stage 1, stage 2 and stage 3.

1st Stage Frost Protection - pumps

1st stage frost protection activates when the outside air temperature falls below the set value, normally 1°C; once activated the heating pumps and shunt pumps shall be enabled, the operation shall terminate when outside air temperature rises to 2°C above this setpoint.

2nd Stage Frost Protection – return water sensing

2nd stage frost protection activates when the return water temperature from any heating zone falls below the set value, normally 5°C; once activated, the lead heating boiler shall be enabled together with the shunt pumps, plus the heating pumps and VT valves(s) for the activated heating zone(s). The differential above this setpoint at which 2nd stage frost protection is terminated is +10oC.

3rd Stage Frost Protection - space

3rd stage frost protection activates when the minimum space temp in the heating zone falls below the setpoint, normally 8 °C; once activated, the heating boiler(s) and all pumps shall be enabled. The differential above this setpoint at which 3rd stage frost protection is terminated is determined by the setting for fan convector or radiator sites. Set to 2°C differential for radiators, set to 5°C differential for fan convectors.

Optimisation Cool-down Limitation (“optimum off”)

Limitation of the optimiser maximum cool down time period is provided, as a function of outside air temperature. The maximum cool down period in relation to outside air temperature is as follows.

Outside air temperature (°C)	Max cool down period (minutes) Fan Convectors	Max cool down period (minutes) Radiators
<0	30	60
0 - 5	45	90
5 - 10	75	120
10 – 14	90	180
>14	180	300

Ventilation and CO2 Control

Control shall be provided of ventilation dampers, roof terminal stack dampers etc in order to control in-room concentration of CO2 and room temperature, and to provide night cooling where specified. It is generally the case that the CO2 controlled ventilation by the BEMS shall be designed to meet winter and mid-season ventilation requirements only, and in summer manual or electric opening windows under control of the occupants shall be the predominant form of ventilation.

For all systems where classrooms are ventilated by CO2 control the following principles should be applied.

Motorised openings (dampers/windows) should be modulating (in steps), the first step typically 10% or less of opening.

Each classroom shall have its own CO2 sensor and temperature sensor.

Each classroom shall have a simple to use time limited user override switch. An on site master override control shall not to be provided.

The controls shall aim to achieve an adjustable set point usually 1000ppm all year round.

The natural ventilation control shall operate in two distinct modes:

Winter and midseason: CO2 control takes precedence. Ventilation openings shall be completely closed when CO2 level is below set point unless classroom temp rises above 23 deg C.

Summer: CO2 control as winter with additionally the dampers opening on the classroom temperature rising above 20 deg C even though the CO2 level may be low.

All ventilation openings shall be completely closed at the end of the occupation period unless night cooling is required.

Optimum off of the heating system may need to be delayed as on some systems the need for heat to temper fresh air will remain throughout the occupied period. This is covered within Part 8-2 and will normally require such circuits to operate on “optimum start, fixed time stop” configuration.

Where specified, night cooling shall be provided by a simple control algorithm similar to the following: “When the mean outside air temperature (monitored between 12:00hrs and 17:00hrs daily) exceed the adjustable setpoint of 16°C and the average space temperature at midnight exceeds the outside air temperature, then

the motorised dampers shall open fully. Once initiated, night cooling ventilation will remain activated for a minimum of 1 hour, night cooling shall terminate once the average space temperature is reduced to 16°C (adjustable) at which point the motorised dampers are modulated closed.

Motorised dampers shall be 24 V AC powered with 0-10 V DC control signals.

A time schedule shall be provided for testing of CO2 sensors. All CO2 sensors shall be checked once a month on a Sunday morning at 4.00 AM and a low level alarm raised if any fall outside the range of 250 - 550 ppm.

Air Handling Units

Control shall be provided for all elements including isolating dampers, supply and extract fans, frost coils, recuperator face/bypass dampers, heater batteries, chiller batteries etc using temperature sensors. Thermostats shall not be fitted other than frost protection types, and these shall be self-resetting; lock-out provision and remote resetting facilities shall be included within the supervisory software. Where recuperators or heat/cool recovery devices are fitted, these shall be controlled to behave as the first stage of heating or cooling. If set point still cannot be achieved with full available energy recovery, only then shall second-stage heating or chiller batteries be enabled.

Hard-wired alarms shall be generated under circumstances of air flow failure, dirty filter conditions, fan motor trip, damper malfunction, frost thermostat activated etc.

Specialist Plant (Chillers, Heat pumps, biomass boiler plant etc)

Where the specified specialist plant does not have facilities for 1-10 volt control signals, or has its own manufacturer's controls with restricted BEMS interface capabilities, the minimum BEMS control functionality shall include enable-disable commands and a common alarm link. Enable-disable command shall operate independently of the mains power contactor/overload supplying the specialist plant, which shall isolate the power to the plant in the event of fire alarm, gas alarm or other external safety event triggering the control circuit.

Combined Biomass/Gas boiler control

Biomass boiler and primary circuit pump control

Biomass boiler to start 6hrs before building occupancy time, (adjustable), or
Add 1hour to start time if outside temperature (OAT) is at 5degc or below, or
Deduct 2hours from boiler start time if oat is above10 degc

Integral controls shall control:-
Output temperature at 85 deg. C.
Modulation of back end motorised valve.
Enable/disable of pump biomass boiler circulation pump.
Wood chip fuel feed system.
Load alarm enable.

Gas boiler/s .

Gas boilers shall be enabled if either;
Any heating circuit flow temperature is 10deg. C below the highest calculated flow temperature, (gas boilers/s will be disabled when the flow temperature is at calculated flow temperature -2deg. C) or
Biomass boiler calls for boiler assist (operator enable/disable set point to be provided). or
Biomass boiler fault alarm active, or
2nd or 3rd stage frost call.

Note

2nd and 3rd stage frost demand shall be serviced by the **gas boiler/s only**, the biomass boiler shall remain off during frost calls unless frost call is within pre-heat period or scheduled times, then normal heating strategy shall take precedence.

Integral gas boiler controls shall control:-
Output temperature at 80 deg. C.
Enable/disable of integral pump

Heating circuits,

All control valves shall close at the start time for the Biomass boiler and primary circuit, heating circuits shall start dependent on the next optimum start call for heating demand. or
3rd stage frost call,
All control valves shall open fully for heat dissipation at the end of the last heating call.

Flow Proving

Water and air flow proving shall be by means of current-transducers in the driving motor circuit. Alarms shall be generated in the event of the motor running current falling below or exceeding pre-set limits.

Alarm and Monitoring Functions

Full BEMS systems incorporate 24-hour monitoring of engineering plant and systems. Communication shall be initiated automatically with the appropriate supervisor station at County Hall by the on-site BEMS controller, via either dial-up or broadband IT link as specified. New alarms shall be displayed in a distinctly separate colour on-screen to distinguish them from previously received and acknowledged alarms. Alarms shall in general 'latch' and remain displayed even when a 'restore' signal has subsequently been received.

Alarm conditions shall be generated in one of two ways.

- Hard-wired alarms – these shall generally be used to connect digital inputs to volt-free contacts provided within items of plant, including trip contacts, lock-out contacts, high temperature thermostats, frost thermostats, low water level contacts, filter dirty pressure switches, high/low pressure switches, low oil tank level, sprinkler plant operation etc. In addition, hard-wired alarms shall be generated in the event of operation of isolating switches in field wiring, plant selector switches on control panels, manual over-ride and time extension switches, to signal their operation to the monitoring bureau.
- Software alarms – these are set up in software under the control of the original programming on commissioning, but also under user remote control via the supervisor terminal. Software alarms shall include: failure to reach set point within a predetermined time after occupation time; controlled variable below fixed value within pre-set period from start of operation; frost protection activated etc.

Logging

The BEMS software shall retain the history of all inputs, outputs and variables for reporting purposes under user control within the Supervisor software. All temperature sensors and motor current readings shall be set up for logging and graphing of points.

Central Station Set up and Graphics Panels

The BEMS installation shall include for the provision of a suite of plant schematic graphics as the principle form of user interface. Each graphic panel shall display dynamic values for time schedules, set points of control loops, temperature sensors, calculated temperatures for control loops, auto-manual overrides, status of each item of equipment and critical alarm points. Where the information cannot be adequately displayed on a single graphic a button shall be provided to display these details, eg, view time schedules.

The designer and commissioning engineer shall agree with Worcestershire County Council's Principal Engineer (Energy) or Worcestershire County Council's Principal Mechanical Maintenance Engineer or Energy team officer the final graphic layout and content for each graphic panel.

The system shall be formally handed over to all or any of the above mentioned officers by the designer and the controls company commissioning engineer. The formal handover procedure is detailed in clause (f) of this document.

The central station and controllers at the time of commissioning shall include the setting up of the following;

- Central station graphics

- Logging and graphing of points
- Calendars
- Time schedules,
Default times heating circuits Mon - Fri 08.30 to 15.30.
Default times domestic hot water circuits Mon - Fri 08.00 to 16.00.
- Setting of all temperature parameters,
Default settings, refer to the point default settings table within the section.
- BST/GMT times and dates
- VT circuit temperature settings

Default settings	Max VT flow	Min VT flow
For radiator site	80°C	30°C
For fan convector site	80°C	65°C

(g) Project handover

The project shall be formally handed over to the members of the Energy Team who are responsible for the operation and running of the system.

The contractor together with the controls manufacturer's commissioning engineer shall provide a complete package of information relating to the system, comprising;

1. Completed commissioning report sheets 1 & 2 attached.
2. Site Plan, detailing the positions of boiler houses/plant rooms, all items of
3. Mechanical services controlled by the BMS, temperature sensors and
4. Heating zones.
5. Plant schematic drawing.
6. Control panel wiring diagrams, as installed.
7. Description of operation for the controls system.
8. Unfinished/snagging items which are still to be completed.

System documentation check list appendix "A" shall be used for final handover to Worcestershire County Council's Energy Team.

Appendix A

HAND OVER CHECK SHEET		YES	NO
1	Completed commissioning report sheets 1 & 2 attached		
2	Site Plan; detailing the positions of boiler houses/plant rooms, all items of mechanical services controlled by the BMS, temperature sensors and heating zones.		
3	Plant schematic drawings.		
4	Central station graphics and programming complete		
5	Control panel drawings, as installed.		
6	Description of operation for the controls system.		
8	Unfinished/snagging items which are still to be completed		

8-3 ELECTRICAL INSTALLATIONS WITHIN BOILER HOUSES AND PLANT ROOMS

COMMISSIONING OF ELECTRICAL INSTALLATIONS AND AUTOMATIC CONTROLS

General

This section covers the on site electrical installation necessary to interconnect the various items of plant together with control equipment to enable the H & V installation as set out to operate as designed. The standards for the electrical installation will apply to all Worcestershire County Council premises irrespective of the type of control system employed, and therefore covers:

Stand-alone controls employing Trend IQ3X controllers as described in 8-1;

'Full BEMS' controls employing Tour Andover 'Infinity' or 'Continuum', Trend 963 remote control systems or subsequent derivatives as described in 8-2..

The Contractor shall ensure that the electrical installation complies fully with the requirements of BS7671 issued by the Institution of Electrical Engineers and its amendments, in addition to the special requirements described in this section of the specification. A final electrical test certificate shall be issued at the completion of the contract or on acceptance of the electrical installation whichever is the sooner. These clauses shall be read in conjunction with Worcestershire County Council's Electrical "Standard Trade Preambles" which shall form part of this specification. Unless otherwise stated or agreed, all non-conducting materials and electrical insulation shall be of the LSF (low smoke and fume) type and emit minimal toxic smoke or fume in the event of a fire.

(a) Free Issue Equipment

The Contractor shall arrange to collect any 'free issue' equipment from the Council's Offices in Worcester as directed by the Contract Administrator, or as detailed in the specification. Items collected shall be signed for and shall then become the responsibility of the Contractor for any loss or damage.

(b) Mounting Panels

All Control Panels/enclosures shall be spaced from the wall on a 40mm Uni-strut frame complete with all Uni-strut accessories and end caps constructed to support the control panels/enclosures. Slotted angle iron shall not be acceptable.

All conduit and trunking entries into the boiler control panels/enclosures shall only be made in the removable entry plates provided, these plates MUST NOT be drilled in situ.

(c) Boiler House Wiring

The Contractor shall supply all the electrical wiring and fittings including all loose control equipment, valves, thermostats, etc required for the installation of the electrical services as detailed in the specification, drawings, control panel drawings or diagrams. All wiring within the Boiler House shall be carried out in surface run galvanised conduit to BS 31, or BS 4568 parts 1 and 2, or heavy gauge galvanised steel trunking to BS4678 or BS EN 50085 - 1, or any combination thereof as required. The use of any other type of containment shall NOT be permitted.

Where any conduit/trunking system drops from high-level and requires support, a length of 40x40mm Uni-strut shall be installed to support the conduit or trunking. Slotted angle iron is NOT acceptable.

Local isolation shall be provided immediately adjacent to all items electrical equipment boilers, pumps, control valves, gas valves etc, (but not temperature sensors) using a 4 pole enclosed rotary isolator switch having minimum 20amp contacts and water resistance rating to IP 65, which can be locked off in the "off" position (e.g. Newlec NLSW 20/4N or equivalent). All isolators shall be mounted on the Boiler House walls or where sited adjacent to boilers, pumps, valves etc. shall be supported by means of purpose made Uni-strut supports.

All cables drawn into conduit/trunking shall be EITHER single conductor LSF or LSOH insulated high temperature grade, OR stranded conductors, such as BICC 'tri-rated' type to BS6231 rated to 105°C, as selected by the Contract Administrator. Multi-core cables and multiple cable runs shall have the number of cores indicated on the wiring drawings/panel wiring diagrams. Earth wires are also to be installed to ensure continuity with a separate earth continuity conductor installed inside the trunking or conduit to each individual circuit wired.

Conductor sizes shall be as indicated on the drawings, or where this is not the case or where there is any doubt as to the correct size to be used, these shall be selected in accordance with the BS 7671, for the current rating of the associated load. When calculating cable sizes for cables run inside boiler houses or plant rooms a minimum temperature of 50°C shall be taken for correction factor "C2".

Where circuits are grouped in one common conduit or trunking/duct run, the Contractor shall ensure that such grouping does not reduce the current rating of the conductors below the rating of the association protective device for the circuits involved.

Final circuit cables used for "low" and "extra low" voltage installations shall be of 600/1000-volt grade minimum and all conductors shall be of STRANDED copper construction. The smallest conductor used shall be 1.5 sq mm.

The insulation of cable/cable terminations shall be of materials entirely suitable for the maximum ambient temperature which could be encountered.

Cables shall be delivered to site, complete with manufacturer's labels and Test Certificates. All such labels, Test certificates and seals shall be detached and retained for inspection by the Contract Administrator.

Joints shall not be permitted in cables; all cables shall be terminated at fittings, switches etc.

In no case shall conductors having two different current ratings be used in combination in a single circuit.

All cables/terminations shall conform as regards colour identification to those set out in BS7671.

Low voltage circuits single phase:	Line	Brown
	Neutral	Blue
Low voltage circuits three phase:	Line L1 L2 L3	Brown
	Neutral	Blue
Extra low voltage AC circuits:	White	
Extra low voltage DC circuits:	Purple	

Final connections to all motors, burners, pumps, valves, thermostats etc. shall be made using nylon corrugated watertight heat-resistant flexible conduit as "Adaptaflex Ltd" type NC finished in black. Adapters shall be straight or 90 degree angled to suit the application giving adequate free length to permit full range of adjustment as on bed mounted belt driven pumps, boiler cleaning and burner maintenance or where access for maintenance is required.

Where the fitting of flexible conduit is not possible as in the case of certain fractional horsepower pumps, the final connection shall be via a high temperature (105°C minimum) multi-core flexible cable with a compression gland fitted at its exit point from the isolator.

All cables shall be terminated at the panel and at the equipment using flat pin, spade crimped ends or bootlace ferrules. Numbered sleeves corresponding to the panel terminal numbers shall be used to mark the cables at the control panel, and at the equipment termination. This is also to include all switches isolators etc. The cable numbering system shall be of a plastic ring type, which shall be fitted to the cable prior to the termination being made. Adhesive tag, clip on or indelible ink marking systems shall not be acceptable.

(d) Earthing

Earth bonding shall be in accordance with BS7671 i.e. where a gas main or water main enters the building at the location of the Boiler House these shall be bonded back to the main earth terminal of the building. The size of the bonding conductor shall be related to the size of the fuses in the main electrical cut-out in accordance with requirements of BS7671. Supplementary bonding to the boilers and any supply pipework shall be carried out in accordance with the requirements of the BS7671.

Separate protective conductors shall be installed for each final sub-circuit.

(e) Temporary Wiring

The Contractor shall allow for all temporary wiring including time clocks and thermostats as required, to run all or parts of the mechanical services due to the final installations not being available to meet the programme or at the request of the supervising officer.

(f) Temperature Sensors

Temperature sensors shall be supplied as detailed in the specification. It shall be the Contractor's responsibility to install the detectors/sensors, and to supply and install the specified 2-core screened cable from the outstation to the detectors. All cables shall be obtained from

Anixter UK Ltd
Unit A
The Beacons
Birchwood Park
Warrington
WA3 6GP

Tel. 01925 810121

When ordering the cable quote reference A4-V02-2002-09-P100 0.5mm 16 stranded 2 core screened cable, having LSOH insulation and sheath. NO OTHER CABLE SHALL BE PERMITTED.

Room sensors shall be mounted at a height of 1.5m above floor level. The cables shall be terminated using bootlace pin terminations; cable screening shall be sleeved to prevent shorting and the cable sheath terminated with an expandable neoprene cable sleeve as RS Components expandable cable sleeve system or other equal and approved.

All sensor cables shall be installed to an approved route, clipped with PVC coated clips fitted with brass roundhead screws and plastic plugs or installed in a dedicated conduit system, fixed, either to fascia boards or to the face of the brickwork, as agreed with the Contract Administrator. Clips shall be fixed at suitable intervals in accordance with the manufacturer's instructions to prevent the cable sagging.

All cables installed at an accessible height (i.e. within 2.5m above ground level) external to the building shall be enclosed in galvanised metal conduit with all necessary fixings. Cables run inside the building shall be enclosed in white plastic mini-trunking or white plastic conduit with appropriate manufacturers fittings and fixings. All detector cables within Boiler Houses or Plant Rooms shall be installed in a separate galvanised steel conduit or trunking system. Twin compartment trunking shall not be used without prior approval.

Internal sensors are to be installed in the rooms specified mounted at a standard height of 1.5m above floor levels, or exceptionally at another height with the prior approval of the Contract Administrator. Where internal sensors are to be fitted on an external wall, these shall be spaced off the wall by using a white plastic pattress taking care to prevent the ingress of cold air which may influence the sensor.

All detector locations to be agreed with the Contract Administrator prior to installation. Detector cables must be run separate from power cables, and the ground/screen/earth must be connected to the terminals at the outstation.

(g) Electronic Thermostats (Fan Convectors Installations)

The Contractor shall install electronic thermostats, type Allen Martin ET.1 adjacent to each of the internal EMS detectors, to control the fan convectors located in each of these areas. Where 2 or more fan convectors are fitted in each of the areas, the Contractor shall allow for the fitting of extra electronic thermostats to each fan convector, final positioning shall be agreed with the Contract Administrator prior to installation.

All thermostats shall be mounted at a height of 1.5 metres above floor level.

NOTE, within School Halls where several thermostats may be required to control fan convectors only one electronic type thermostat shall be installed; all others shall be of the adjustable type.

(h) Fan Convector Fused Connection Units

Fan convectors shall be fitted with key operated double pole switched 13 amp FCUs fused at 3 amps with neon indicators.

(i) Labels

Provide and fix Ivorine or Traffolite labels adjacent to each item of equipment to give a clear indication of its function. Wording shall generally coincide with that on the new control panel as appropriate. Labels shall be fixed with screws and not attached to the lids of any equipment.

(j) Telephone Box

The Contractor shall mount on the wall at the British Telecom socket position a Legrand box supplied "free issue" by Worcestershire County Council. The Contractor shall install a 20mm galvanised conduit and draw wire between the telephone box and the Outstation position; the distance between the control panel and the phone box is to be no greater than 0.5 metres. Final interconnections to the outstation shall be agreed on site with the Contract Administrator.

(k) Burners and Boilers

Wiring to boilers and burners shall be carried out in accordance with the Manufacturers recommendations, with the additional requirement that remote indication on the control panel and through the BEMS is provided by the burner whenever 'lockout' and 'high temperature overheat' conditions occur or when the burner mains supply is isolated. The wiring must be carried out such that when the control circuit is off, the alarm circuit remains indicating until the manual reset is operated. The wiring to the burners shall be of sufficient free length to permit the opening of the boiler/burner for servicing purposes.

(l) Testing

The Contractor must test the complete installation on completion in accordance with the requirements of BS7671. It must be noted that when a 500-volt Insulation resistance tester is used, extreme care must be taken not to damage or back feed electronic circuits.

(m) Boiler House Lighting and Power

Any existing lighting fittings within the boiler house are to be replaced with 1,500mm Thorlux FG range or other equal and approved fluorescent luminaires, having T5 tubes and high frequency ballast and in either single or twin configuration to give a good level of illumination as defined by the CIBSE Lighting Guide. Wiring for the new fittings shall be carried out in galvanised conduit and cabling taken from a local distribution board. Any existing 13 amp SSOs in the boiler house are to be removed.

Under no circumstances shall power for lighting circuits within the boiler room be taken from the Boiler House control panel.

(n) Segregation

Low voltage (Category 1) "Extra Low" Voltage (Category 2) also fire alarm and emergency lighting circuits (Category 3) and any other system (including private telephones, British Telecom telephones, public address, etc.) shall each be contained in completely separate conduit and/or trunking/wiring systems. In existing composite systems trunking channels are regarded as separate where barriers are interposed between them and the wiring is properly retained in each section by means of insulated retaining clips.

Where systems wired using Mineral Insulated Copper-sheathed cables, PVC/SWA/PVC cables or other systems, or a mixture of types, each shall be wired entirely separately without using common containment routes.

(o) Broadband connection (All systems)

A local area network data cable shall be installed within the boiler house adjacent to the HVAC control panel, the network connection shall provide a fixed IP address which will be linked through area network hubs to the main incoming broadband connection server.

(p) Boiler House Fire/Safety Circuit

The system shall consist of an emergency knock-off button to be located by the boiler house door (away from light switches) and heat detectors over the heating and domestic hot water boilers; a minimum of 2 heat detectors shall be installed within each boiler house.

The heat detectors shall be of the re-settable type incorporating a mercury type switch, as Blacks 'Teknigas' manually re-settable fuses, BC66MRF or other equal and approved, obtainable from:

Blacks Teknigas
Bydland Lane
Little Paxton
St Neots
Cambridge
PE19 6EG

Heat detectors with 'sacrificial links' of the low-melting point alloy type shall not be acceptable.

The knock-off button is to be of the lock/stop, twist to re-set type. A suitable label shall be fixed adjacent to the button to read 'EMERGENCY STOP BUTTON'.

In addition to the above plant fire safety circuit, the boilerhouse or plant room shall itself be fitted with a fixed-temperature heat detector and a fire alarm sounder, both connected to the building fire alarm system. In case the existing building fire alarm system is not compatible with this requirement, the Contract Administrator shall be consulted.

COMMISSIONING OF AUTOMATIC CONTROLS & ASSOCIATED ELECTRICAL INSTALLATIONS

Commissioning Sequence

1. Carry out visual checks, confirm that the electrical installation is complete, advise contractor as necessary to complete electrical installation before commencement of commissioning.
2. Confirmed that the installation complies with this section of the Specification and the County Council's Engineering Trade Preambles, Mechanical Services.
3. Remove all temporary wiring for the clocks/frost protection.
4. Commission all control panels, check all electrical terminations for tightness.
5. Check for correct operation of all control valves and ensure correct 'porting'.
6. Check for correct rotation of all pumps and fan motors, and confirm correct automatic changeover in the event of faults.
7. Check wiring of all-heating boilers and domestic hot water boilers/heaters for normal control sequence (wiring scheme as shown on the control panel wiring diagrams). Check high limit and lockout conditions for alarm and that alarm retention operates on removal of the alarm input.
8. Check for operation of all digital input alarm and control strings with reference to each item as detailed on the panel drawings and the BEMS points schedule including local electrical isolators to pumps, valves, damper etc.
9. Check location of all BEMS sensors and thermostats with reference to each item as detailed on the panel drawings, in the specification and the BMS points schedule.
10. Check operation of all fan convector thermostats fitted under this contract and provide a record of fan speeds and thermostat settings.

Detailed Commissioning of the Automatic Controls

The purpose for which the County Council requires such detailed attention to commissioning at this stage is to satisfy itself that all new control systems which the Contractor proposes to connect to the Council's BEMS network, and for which the Council is required to take operational responsibility, comply in all respects with the Council's design and construction standards and will not compromise the operation of the Council's network, nor require special or individual consideration by the operational team responsible for 250 other sites.

The Contractor shall be responsible for the commissioning, of the total System. The Contractor shall allow within his tender for the attendance on site of the electrical installation contractor during all phases of the commissioning process.

The controls commissioning shall be carried out by a Specialist who is conversant with HVAC control systems; all stages of the commissioning shall be fully documented as detailed on the commissioning report sheets (samples shown below). The commissioning reports shall be signed off as complete by the contractor; these shall form part of the Health and Safety File and the O & M manuals.

The contractor shall supply a complete specification and drawing package to the Commissioning Specialist prior to the start of the commissioning. The Commissioning Specialist shall be competent and experienced in the type and scope of the automatic controls equipment and installation, and shall be acceptable to the County Council.

The commissioning shall be carried out in two phases.

Part 1: Pre-commissioning -

Complete the Pre-commissioning report (sheet 1) and sign off as complete.

Carry out full functional and electrical checks of the total control system with the outstations and controllers powered off, as listed below and as detailed on the commissioning report sheets. Have possession of the latest up-to-date wiring/panel diagrams including any modifications.

Part 2: Final Commissioning -

Complete the Final Commissioning report sheet and sign off as complete.

Controls manufacturer to carry out commissioning of BMS outstations and controllers. The pre-commissioning specialist shall be in attendance and assist with the commissioning as directed by the controls manufacturers commissioning engineer. Commissioning shall include full functional thermal and electrical tests; complete all sections of the commissioning report. Carry out the programming of the central station, list all outstanding faults/defects, and rectify defects as necessary. The Contractor shall arrange for a formal hand over of a full working system to the Energy Group Engineers at County Hall Worcester. On no account shall the system be fully accepted until all outstanding defects have been rectified.

Project Handover

As part of the handover process the Contractor together with the controls manufacturer shall be required to demonstrate the operation of the system to the supervising officer and the Site Manager. The County Council will not normally accept handover of the entire project until the automatic control system has been accepted and all works have been completed.

WORCESTERSHIRE COUNTY COUNCIL

PRE COMMISSIONING PART 1

PRE-COMMISSIONING REPORT SHEET

SITE

Pre-commissioning Part1: -

Complete Pre-commissioning report sheet 1 and sign off as complete.

Carry out full functional and electrical checks of the total control system with the outstations/controllers powered off, as listed below and as detailed on the commissioning report sheets. Have possession of the latest up-to-date wiring/panel diagrams including any modifications carried out in the construction phase.

PLEASE ADD ANY COMMENTS AT THE BOTTOM OF THIS SHEET

1. Carry out visual checks, confirm that the electrical installation is complete, advise contractor as necessary to complete electrical installation before commencement of commissioning.
COMPLETE **YES/NO**

2. Confirmed that the installation complies with Specification and The County Councils Trade Preambles, Engineering Mechanical Services
COMPLETE **YES/NO**

3. Remove all temporary wiring for the clocks/frost protection.
COMPLETE **YES/NO**

4. Control panel commissioned.
COMPLETE **YES/NO**

5. Check operation of all control valves and porting.
COMPLETE **YES/NO**

6. Check rotation of all pumps and fan motors, automatic changeover in the event of faults.
COMPLETE **YES/NO**

7. Check wiring of all-heating boilers and domestic hot water boilers/heaters for normal control sequence (wiring scheme as shown on the control panel wiring diagrams).
 Checked high limit and lockout conditions for alarm and alarm retention.
COMPLETE **YES/NO**

8. Check for operation of all control outputs with reference to each item as detailed on the panel drawings and the schedule of point's.
COMPLETE **YES/NO**

9. Check for operation of all digital input alarm and control strings with reference to each item as detailed on the panel drawings and the BMS points schedule including local electrical isolators to pumps, valves, damper etc.
COMPLETE **YES/NO**

10. Check location of all sensors and thermostats with reference to each item as detailed on the panel drawings, specification and the BMS points schedule.

COMPLETE

YES/NO

11. Check operation of all fan convector thermostats fitted under this contract and shall have a record of fan speeds and thermostat settings.

COMPLETE

YES/NO

12. Check operation of the extension run-time facility and ensure than an explanatory sheet is affixed near the panel. Check the operation of the manual override facility.

COMPLETE

YES/NO

13.

Company carrying out the Part 1 commissioning

Company Name

Engineer's name, please print and sign

Name, please Print

Name please sign

Date.

COMMENTS

WORCESTERSHIRE COUNTY COUNCIL

COMMISSIONING PART 2

COMMISSIONING REPORT SHEET

SITE.

Commissioning Stage 2: Complete Commissioning report sheet and sign off as complete.

Controls manufacturer to carry out commissioning of BMS outstations and controllers. The Commissioning Specialist shall be in attendance and assist with the commissioning as directed by the controls manufacturer. Commissioning shall include full functional thermal and electrical tests; complete all sections of the commissioning report. Carry out the programming of the central station at County Hall, list all outstanding faults/defects, and rectify defects as necessary. Arrange for a formal hand over of a full working system to the Supervising officer and Energy Group Engineers at County Hall, Worcester. On no account will the system be accepted by Worcestershire County Council until all outstanding defects have been rectified.

COMMENTS

OUTSTANDING DEFECTS

Company carrying out the Part 2 commissioning

Company Name

Engineer's name, please print and sign

Name, please Print

Name please sign

Date.

8-4 SPECIAL REQUIREMENTS FOR MANUFACTURE OF CONTROL PANELS AND ENCLOSURES

The control panel/panels shall be manufactured in accordance with the following specification and as detailed on the drawings or in the Schedule of Materials:

(a) Control panels and enclosures

All control panels and enclosures shall be manufactured from sheet steel in a thickness appropriate to size and manufactured to IP54 rating, complete with galvanised steel back plates.

All panels and enclosures shall be corrosion protected and finished in semi-gloss acrylic paint appropriate to the prevailing conditions within the boiler house or plant room. Enclosure doors shall be sealed by expanded neoprene gaskets and secured by compression locks, key number LF92300.

Any panels, enclosures housing HVAC controllers shall be manufactured to type "Form 2" providing a separate controls and power sections.

All equipment fitted within the panel enclosure shall be fixed to the back plate; the rear of the doors may be used for the mounting of HVAC controllers only, and where the rear of the door is utilised the controllers shall be mounted on rails spaced off the door. On no account shall the fixings screws protrude through the front of the control panel door. There shall be an allowance of 15% spare back plate capacity built into the control panel design for future expansion. Where HVAC controllers have expansion ports as part of their design, these ports shall be left accessible for future use.

A minimum size of 1200mm by 1200mm panel enclosure shall be provided for the main panel containing the BEMS modem, where fitted. All sub-panels shall be sized only to provide the 15% spare capacity for future expansion.

The construction of the control panel shall be such that no terminals at a potential exceeding 24 volts AC or DC are accessible to the touch. All terminals shall be of the shrouded pattern but must permit access to competent test personnel using approved test equipment for fault-finding purposes. Particular attention shall be paid to the internal faces of opening panel doors.

(b) BMS Outstations / Controllers

The HVAC controllers shall be securely mounted to the base plate or on the rear of the panel doors. The panel manufacturer shall pre-wire to all of the analogue inputs within the controllers to the outgoing terminal rail.

All wiring to digital and analogue cables shall be separately routed within the trunking system away from the main load carrying cabling. A double pole isolator shall be incorporated within the controls section of the panel to provide electrical isolation to all of the HVAC controllers contained within.

(c) Components

All internally mounted components shall be secured to the mounting plates by screws into suitable tapped holes. Relays, contractors and MCB's shall be DIN rail mounted.

(d) Contactors

As manufactured by Telemecanique, IMO or International Control Gear Ltd.

All panels shall incorporate a main contactor rated to the full load of the control panel. Contactors shall all be rated to AC3 specification.

(e) Main isolator

All panels and enclosures shall be provided with a door-interlocked on-load isolator mounted near the top of the door on the power section only, with the facility to be locked in the 'off' position.

(f) Motor Control Gear

As manufactured by Telemecanique, IMO or International Controls Ltd, all fitted with separate overload contacts (i.e. not forming part of the starter control circuit) which shall be of the manual reset type, resettable from within the panel. Overloads shall be selected for mid range wherever possible or a margin of 15% shall be allowed above the FLC rating of the motor.

Where variable-speed pumps, fans and motor drives are to be connected to specific control panel circuits, traditional starters and overloads shall not be fitted. However, the same functionality relating to auto-changeover, alarms, duty/standby rotation etc shall be achieved within the control panel wiring and controller software.

(g) Relays

All relays to be OMI or Omron MY4 or G2R type with a minimum contact rating of 5amps, latching lever and flag or LED indication in the energised position.

Circuits requiring more contacts than those provided on the relays shall be fed via a slave relay wired in parallel to the existing relay.

(h) MCB's

All MCB's shall be of Merlin Gerin manufacture rated to a minimum of 6amps, 6kA breaking capacity to BS 3871, DIN-rail mounted and wired in a ring main. All circuits shall be fed from the switched side of the main isolator, except the supply to the RCD protected switched socket outlet and the supply to the HVAC controllers, or where specifically called for on the drawings or specification. Where circuits are fed from the live side of the panel isolator, warning labels appropriate to the hazard and suitable shrouding of all live parts shall be fitted.

All circuits shall be fitted with Merlin Gerin 26929 MCB Auxiliary Contacts to provide isolated and tripped/overload indication; these shall be wired to the relevant digital input circuits as detailed on the points schedule. MCB auxiliary contacts shall be hard wired to a dedicated volt-free auxiliary contact terminal block, and from this point wired into the relevant digital input circuits as detailed on the points schedule.

(i) Control circuits

A dedicated control circuit rated at a minimum of 6amps shall be provided within all panels/enclosures, which shall operate at a voltage of 24 volts AC. This shall only be used to switch electrical equipment and operate indicator lamps within the panel; under no circumstances shall the dedicated panel control circuit be used to switch any electrical services external to the panel/enclosure.

Dual pump sets to provide automatic changeover in the event of trip or isolation, and boiler circuits to indicate 'boiler isolated'.

(j) Socket Outlets

An RCD protected switched socket outlet shall be fitted to the side of all control panels, as MK.6302 ALM with 30mA sensitivity.

(k) Panel indication Lamps

Multi cluster LED lamps of 22.5mm diameter shall be used for all indication lamps; lamps shall be fitted to the fascia of the control panel to indicate the following.

1. Control panel live
2. MCB control circuit fail.
3. Fire circuit Operated.
4. Boiler "On".
5. Boiler Isolated.
6. Boiler High-limit.
7. Common Boiler Fault, where it is not possible to separate Lockout and High-limit conditions.
8. Pump Run.
9. Pump Trip.
10. Electric water heater "On" lamps.
11. Fan convector "On" lamps.
12. High & Low LTHW system pressure or pressurisation unit isolated.
13. Any other items of equipment which are controlled from the control panel

Indication lamps as detailed above shall be fitted for each item of plant to indicate fault and run conditions. A single indication shall not be used to indicate more than one function on each item of plant.

Lamp Colours:-

Control Panel Alive,	White
Control Circuit Fail,	Red
On and Run indication,	Green
Isolated and Tripped indication,	Red
BMS Common Alarm,	Red
BMS Extension Applied,	Orange
Frost Condition	Blue

(l) Push Buttons

As Telemecanique, IMO, Toshiba or International Control Gear Ltd, 22.5mm dia. push button switches.

(m) Rotary Switches

Telemecanique, IMO, Toshiba or International Control Gear Ltd, 22.5mm dia. rotary switches having 60 degree angle incremental switching positions. Important note: a "HAND" position shall NOT be included as part of the control panel design. Switches shall have "AUTO" and "OFF" positions only. **Manual operation and/or manual over-ride of all WCC plant is enabled by the master extension switch.**

(n) Field Wiring Terminations/Terminals

All terminals shall be screw type, Klippon or Telemecanique, size to suit individual cable loadings. The use of screwless terminals shall not be permitted.

The terminal rails shall be positioned no more than 150mm from the top of the control panel back-plate. Power wiring and controls wiring terminals shall be kept separate and within the respective sections of the control panel, i.e.

Power wiring, Fire circuits, Functional Switching circuits – Power section
Analogue inputs and digital inputs - Controls section.

The panel manufacturer shall ensure that separate cable looms are provided for control outputs wiring and analogue/digital input wiring.

(o) Cable Entry

Top and bottom to be provided with gland plates and seals.

(p) Internal wiring

Internal wiring to be in PVC cable to BS 6231 type B flexible, colour coded as appropriate, and sized to meet current requirements.

Low voltage circuits single phase:	Line	Brown
	Neutral	Blue

Low voltage circuits three phase:	Line L1 L2 L3	Brown
	Neutral	Blue

Extra low voltage AC circuits:	White
Extra low voltage DC circuits:	Purple

Note, where there is a requirement for the use of screened cables a separate cable shall be used for each circuit, number of cores appropriate to the application; a single multi-core cable form shall not be used to group together several circuits.

All internal wiring is to be fully identified by numbers, and terminated using flat pin, spade, fork or bootlace crimped connections.

The control circuit shall always be fed from phase L1.

Cable runs to control panel doors shall be sub-divided into reasonably sized looms, securely bound and anchored to avoid chaffing and trapping. Separate looms for digital alarm and analogue circuits shall be provided between the panel doors and back plate.

(q) Labelling and Identification

Fixed labels shall have black text on white background, with appropriate headings and descriptions to suit the application. Fascia labels to be approximately 150mm x 140mm for each item of mechanical equipment. All switches and lamps for twin head pump sets, boilers etc shall be arranged on single fascia labels; split labelling for these mechanical items shall not be acceptable. Internal labelling shall be Traffolite permanently secured to ducting lids identifying all equipment, etc. Relays to be identified as described under the heading of relays, transformers, starters, contactors, etc., shall be fully identified individually, e.g. DHWS PUMP No.1, BOILER No. 2, HEATING PUMP No. 2, etc. Pumps and starters shall also identify the areas which the pumps are serving.

(r) MCB Chart

The panel manufacturer shall provide a plastic covered MCB chart which shall be secured to the inside of the panel, identifying the circuit, the circuit rating and any contactor/starter, etc.

(s) Wiring Diagrams

The panel manufacturer shall provide all wiring diagrams for the panel, produced in A3 landscape format with page numbering and grid references lines for each page; page numbering shall conform to the following format:-

GA - General arrangement, cabinet size, layout fascia label details.

P - Power drawings.

C - Control circuit drawings

All relays and contactors shall have a unique reference which shall relate to the page and reference line (examples of this system are available on request) the drawings shall include all HVAC manufacturers' equipment wiring and terminal connection details (boilers, pumps, pressure sets, AHUs, inverter drives etc). Prior to manufacture, two copies (A3 minimum size.) shall be forwarded to the Panel Manufacturer's client (Consultant, Contractor etc), who shall be responsible for checking and amending before submitting to Worcestershire County Council (WCC) for information and comment. All drawings submitted to WCC shall be accompanied by:

Mechanical schematic drawing.

Electrical schematic drawing.

BMS points schedules.

Manufacturers electrical drawings, boilers, pumps etc with all electrical loadings (Voltage, Current, Power kW).

All previous issues of the control panel drawings.

Note that until all relevant information is received, WCC cannot undertake to comment on any panel drawings submitted. It shall be the responsibility of the Contractor to forward all information and to instruct the panel manufacturer to commence with manufacturer of the control panel.

The Panel Manufacturer shall supply directly to WCC two sets of 'as-installed' drawings, (A3 minimum size) which shall be provided in addition to the drawings supplied as part of the contract.

Final 'as-installed' wiring diagrams covered in a plastic sleeve shall be provided inside the control panel.

Where the control panel drawings have been produced using an AUTOCAD system, in addition to the white prints an electronic copy of these shall also be provided.

The purpose for which the County Council requires these drawings at this stage is to satisfy itself that all new control systems which the Contractor proposes to connect to the Council's BEMS network, and for which the Council is required to take operational responsibility, comply in all respects with the Council's design and construction standards and will not compromise the operation of the Council's network, nor require special or individual consideration by the operational team responsible for 250 other sites.

(t) BMS Controller Outputs

Each output from a BMS Controller shall only be used to switch control circuits to relays and contactors, etc. The outputs shall not be used to switch any item of plant directly.

(u) Dual Electrical Supplies

Any electrical supplies or 'live' control circuits from remote control panels, and supplies originating from the live side of the main isolator, shall be shrouded by insulating materials and suitably labelled to indicate the source of electrical energy. Isolating terminals shall be used on all electrical supplies feeding into the control panel and its enclosures.

(v) Delivery

The control panel manufacturer shall include for the delivery of all panels and enclosures to the site, delivery to be pre-arranged to suit the progress of the contract. Off-loading at site shall be the responsibility of the panel manufacturer who shall supply all manual labour and any handling equipment required.

MISCELLANEOUS EQUIPMENT

9-1 THERMOMETERS

Thermometers shall be installed where indicated in this Specification (refer to sections 2 and 5)

Thermometers shall be positioned so that the tails are truly subjected to the temperature of the water to be measured.

Right angle or obtuse angle thermometers shall be provided for fitting to vertical pipes or vertical faces of cylinders, etc.

Dial thermometers are to be used, they shall be with an appropriate scale, metal cased 100 mm dia , and shall be as manufactured by either Stewart Buchanan, Brannan, BSS, Coley, or Zeal. All gauges (temperature and pressure) in any boiler room are to be of the same type and manufacture.

9-2 PRESSURE/ALTITUDE GAUGES

Altitude gauges shall be installed where indicated in this Specification (refer to sections 2 and 5)

Gauges used solely to indicate the altitude or head and pressure of the water shall have dials not less than 100mm diameter, calibrated both in bar and metres head and shall have a range to suit the application. In addition to an indicating black pointer gauges shall be provided with an adjustable red pointer set to indicate working pressure or head of the system with white dials. Gauges shall be fitted with lever handle cocks and shall be of the metal cased bourdon tube type, as manufactured by either Stewart Buchanan, Brannan, BSS, Coley, or Zeal. All gauges (pressure or temperature) in any boiler room are to be of the same type and manufacture and shall be fitted with a gauge cock and siphon tube.

9-3 THERMOSTATS

Unless otherwise detailed on the drawings or in the Specification, thermostats shall be as specified below:

Room Thermostats: Sunvic TLX 2259 or Drayton RTS1 (10-30 degC), to be mounted 1.5 above FFL. Thermostats shall be fitted with limit stops.

Frost Thermostats: Satchwell TLM 2257 (-15 to +10degC)

Electronic Thermostats: Allen Martin ET.1

Combined Boiler Control/high limit: Satchwell TKD 3501

Boiler Control: Satchwell TK 3501 (85degC) (if not provided with the boiler)

Boiler High Limit: Satchwell TKR 3501 Manual reset (95degC)

Remote reading High limit/manual reset/changeover Landis & Gyr RAK 21.4.1.2 chassis, or 22 cased.

Heater Battery capillary stat: Landis & Gyr RAK 32.0001.1, 1600mm 10-50degC.

Immersion thermostat: Satchwell TK 3501 20-90 degC. Thermal reset.

Pipe-mounted hold-off stats – Sontay ST-SS01

Where the thermostats are used externally, they shall be fitted in an ABS waterproof enclosure.

Where protection is called for to internal thermostats a wire cage is to be supplied and fixed suitable for the size of the thermostat.

9-4 TIME SWITCHES

All time switches shall be as detailed in Schedule of Materials or drawings, and shall be quartz control with battery reserve pattern as manufactured by Sangamo, or Honeywell ST799.

PART 10**THERMAL INSULATION****10-1 GENERAL**

Thermal Insulation and methods of application shall comply with the requirements of BS 5422 and BS 5970 and the Building Regulations as applicable to the services covered in this Specification.

All thermal insulation work shall be carried out by a specialist contractor approved by the Thermal Insulation Contractors Association.

All materials shall be used strictly in accordance with the manufacturers installation and material safety data sheets.

All insulating materials shall be Class O as defined in the Building Regulations, Approved Fire Safety Document (B), Appendix A12 and shall have a Smoke Emission Rating below 5% in accordance with BS 5111:Part 1.

All materials shall be CFC-free. Materials containing asbestos or un-bonded loose fibres shall not be used.

Materials installed in kitchens, food processing areas, clean rooms and aseptic areas shall be non-fibrous.

Before application of insulation, the pipework shall be pressure tested, cleaned and dried. Any scale, rust, grease and dirt shall be removed. Copper pipework shall be thoroughly cleaned to remove all traces of surplus soldering flux, building materials debris and dust.

10-2 INSULATING MATERIALS

Proprietary materials are noted for the items below to ensure that quality control, fire performance and construction are as certified by the manufacturer and that packaging ex works protects and identifies the materials on site. Requests for approval of alternative materials shall be accompanied by the manufacturers certification of equivalent quality and performance.

PHENOLIC FOAM shall be Kooltherm Class O, bore coated, closed cell, rigid pre-formed pipe sections having a nominal density of 35kg/m^3 , a factory applied Class O reinforced aluminium foil jacket and fully aged thermal conductivity of 0.018 W/m K at 10°C and 0.023 W/m K at 50°C mean temperature. As manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

MINERAL WOOL shall be resin bonded rock or glass fibre, Class O, rigid pre-formed pipe sections having a minimum nominal density of 80 kg/m^3 , a factory applied Class O reinforced aluminium foil jacket and fully aged thermal conductivity manufactured by Rockwool Ltd, Owens Corning Ltd, or equal and approved.

FLEXIBLE FOAM (use only where specified) shall be Armaflex Class O nitrile rubber flexible pre-formed pipe sections having a minimum nominal density of 90 kg/m^3 and fully aged thermal conductivity of 0.040 W/m K at 10°C and 0.044 W/m K at 50°C mean temperature. As manufactured by Armacell UK or equal and approved.

10.3 INSULATION THICKNESS

The thickness of insulation shall be in accordance with the Environmental Thickness Tables in BS 5422 (Rev 12-2001) proposed as the basis for Government Enhanced Capital Allowances for thermal insulation under the Climate Change Levy.

Refer to Thickness Tables 1,2 and 3 in Clause 10-11 of this specification.

10-4 BOILER HOUSE/BOILER ROOM

All pipework, valves and flanges within Boiler Houses/Rooms shall be insulated as described below :-

- (a) Phenolic Foam foil faced rigid pre-formed sections in 1 metre lengths secured by equally spaced bands of 50mm wide self-adhesive aluminium foil tape at 300mm centres

OR

Mineral Wool Foil faced rigid pre-formed sections in 1 metre lengths secured by equally spaced 15mm wide lightweight aluminium bands at 300mm centres.

- (b) The insulation (phenolic foam or mineral wool) shall be additionally protected by means of hammerclad aluminium cladding to a minimum thickness of 0.7mm secured by means of pop-rivets or self-tapping screws. Termination points to be fitted with end caps, fitted to permit easy disconnection of flanges and valves. Valves and flanges of 50mm and above to be provided with removable insulated covers manufactured from 1.0mm thick hammerclad aluminium and fitted with quick release toggle fasteners or proprietary flexible waterproof insulating jackets.
- (c) The following protective finish shall be used as an alternative to hammerclad aluminium where specifically called for by the Contract Administrator.

Phenolic Foam or Mineral Wool insulation as described above but protected by Isogenopak Rigid PVC Sheet 0.35mm thick installed in accordance with the manufacturer's recommendations.

Longitudinal and circumferential joints shall be lapped by approximately 40mm.

Longitudinal laps shall be secured by Isogenopak plastic rivets at about 100mm centres.

All fittings shall be finished with Isogenopak pre-formed covers.

10-5 PIPES IN ROOF SPACES, CEILING AND VOIDS, FLOOR DUCTS etc.

All pipework (including heating, hot water supply, cold water supply and mains water supply) within roof spaces, roof voids, ceiling voids, horizontal and vertical ducts, floor ducts, skirting ducts and all shafts shall be insulated using Phenolic Foam or Mineral Wool pipe sections with factory applied reinforced aluminium foil jacket having a Building Regulations Class O fire rating and water vapour permeability in accordance with BS 5422:1990 Table 1.1

Insulation sections shall be fitted tightly to the pipe surface with circumferential and longitudinal joints closely butted together.

All joints of the aluminium foil jacket shall be vapour sealed with Idenden Type T303 self-adhesive foil tape. The width of tape used shall be 50mm for phenolic foam and 75mm for mineral wool. Additional securing in position shall be carried out with light gauge aluminium bands or bands of T303 tape at not less than 350mm centres. On cold water services, all insulation terminations eg at valves and flanges shall be vapour sealed with strips of Type T303 tape carried over the edge of the insulation and onto the pipe a minimum distance of 50mm.

All terminations shall be fitted with aluminium end caps.

All elbows and bends (90° and 45°) shall be insulated with factory cut pre-formed bends manufactured from the same material as the pipe insulation, or manufactured from section on site by the Contractor so that the insulation fits all bends and elbows.

All flanges and valves shall be insulated as above with insulation sections cut to suit the largest diameter of the flange or valve and to the same thickness as the insulation on adjacent piping. The length of oversize section shall be sufficient to overlap the pipe insulation by 75mm on both sides of the fitting. Sufficient space shall be left between the end of the pipe insulation and the flange to allow withdrawal of flange bolts.

At pipework supports the insulation, aluminium foil jacket shall be continuous and not punctured by the supports. The insulation at supports shall be Kooltherm K-Block pipe support inserts manufactured

from high density phenolic foam designed to support the loads transmitted. The length of the K-Block load-bearing insulation shall extend on each side to the supports to facilitate sealing of the aluminium foil jacket. K-Blocks shall be as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

10-6 **SMOKE PIPE AND BOILERS**

All smoke pipes within the boiler room shall be insulated with one of the following.

- (a) Expanded metal mesh shall form a 25mm air gap, 40mm plastic Calcium Silicate (asbestos free), super-coated with 15mm thickness of hard setting asbestos free composition, trowelled smooth and painted two coats to a colour selected and agreed with the Contract Administrator.
- (b) Expanded metal mesh shall form 25mm air gap, 50mm Mineral Wool quilting securely wired, protected by means of aluminium clad sheeting, secured by means of pop rivets or self-tapping screws.

In either case the insulation is to be provided with purpose built access panels for clean out doors and test points, which can easily be removed and replaced.

10-7 **H.W.S. CYLINDERS AND CALORIFIERS**

Cylinders and calorifiers shall preferably be supplied pre-insulated by the manufacturer, where this is not possible, they shall be insulated with one of the following.

- (a) Phenolic Foam, 35mm thick foil faced flat-wrap, protected by means of hammerclad aluminium sheeting minimum thickness 1.0mm (19 gauge), secured by means of pop rivets or self tapping screws.
- (b) Mineral Wool, 65mm quilting securely wired, protected by means of hammerclad aluminium sheeting minimum thickness 1.0mm (19 gauge), secured by means of pop rivets or self tapping screws.

All insulation coverings shall be such as to permit easy access to any bolted head or manhole for cleaning purposes, and be clear of all unions on the pipework connections to permit removal of the cylinder/calorifier to permit removal without dismantling the insulation.

10-8 **COLD FEEDS AND OPEN VENTS**

All cold water feeds and open vent pipework within the Boiler House which remain uninsulated as directed by the Contract Administrator, shall be painted two coats of anti-condensation paint.

10-9 **TANKS AND CISTERNS**

All tanks and cisterns shall be pre-insulated with integral bonded material on all sides all as per the Clause 5-3.

10-10 PIPEWORK IN OPEN AIR OR DUCTS EXTERNAL TO THE BUILDING

Pipework shall be insulated as specified in Clause 10-5, and the outer covering shall be weatherproof and applied to all the pipework.

- (a) Weatherproof finish shall be one of the following:-
- (1) Encacel-T weatherproof elastomeric mastic applied in two coats reinforced with No.10 open weave glass-cloth embedded between the coats. The coverage rate for each coat shall be 1 litre/m² as manufactured by Kingspan Industrial Insulation Ltd or equal and approve.
 - (2) Roofing felt, with overlaps not less than 50mm at the joints sealed with adhesive. The whole to be additionally secured by wrapping with 25mm mesh x 1mm thick galvanised wire then painted with two coats of bituminous paint.
 - (3) Polyisobutylene sheet not less than 0.8mm thick and of tensile strength not less than 3.4 MN/m², lapped and sealed by manufacturers solvent welding fluid.
 - (4) External grade rigid plastics of 0.35mm minimum thickness, lapped and sealed by manufacturer's recommended solvent welding fluid or adhesive.

The finishes specified in Clause 10-8(a) (2) to (5), shall be perforated on the underside of all horizontal runs with 6mm diameter holes at approximately 150mm centres. All lapped joints shall preferably lie to one side of the bottom centre line so that the perforations are made through one thickness of the material only, with the underlying pre-formed insulation open to the atmosphere at these points.

- (b) At pipework supports, the insulation, aluminium foil jacket and outer covering shall be fully sealed and continuous and shall not be punctured by the supports. The insulation at supports shall be Kooltherm K-Block pipe support inserts manufactured from high density phenolic foam designed to support the loads transmitted. The length of the K-Block load bearing insulation shall be extended on each side to the supports to facilitate sealing of the finishes. The K-Blocks shall be as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

At entries into buildings the weatherproofed insulation shall extend not less than 100mm beyond the inner face of the wall and be sealed to the satisfaction of the Contract Administrator.

- (c) At flanges, expansion joints and anchor points, particular attention shall be paid to sealing the insulation against water vapour ingress.

10-11 PAINTING

All insulation shall be painted with two coats of good quality heat resistant paint except where concealed or protected by metal casings, weatherproof finishes or special decorative protected finishes. Absorbent surfaces shall initially be given a coat of priming paint.

10-12 COLOUR CODING

All types of insulation shall be colour coded, to comply with BS 1710 and with the instructions of the Contract Administrator. All pipework shall be colour banded and have direction arrows.

10-13 INSULATION THICKNESS TABLES**TABLE 1 Insulation thickness on HWS and LPHW pipework in accordance with BS 5422 (REV 12-2001) Environmental Thickness Table 11**

Nominal Bore of Pipe (mm)	Phenolic Foam thickness (mm)		Mineral Wool thickness (mm)		Nitrile Rubber thickness (mm)	
	HWS	LPHW	HWS	LPHW	HWS	LPHW
15	15	15	30	40	45	50
20	15	20	40	40	45	50
25	20	20	40	40	50	55
32	20	20	40	50	50	55
40	20	25	40	50	50	60
50	20	25	40	50	50	60
65	25	25	40	50	55	60
80	25	30	50	60	55	65
100	25	30	50	60	55	65
150	25	35	50	60	55	70
200	30	35	50	60	60	70
250	30	35	50	60	60	70
300	30	35	50	60	60	70
Vessels	35	40	50	65	65	75

TABLE 2 Insulation thickness on chilled and Cold Water pipework in accordance with BS 5422 (REV 12-2001) Environmental Thickness Table 9

Nominal Bore of Pipe (mm)	Temperature of pipe contents					
	+5°C			0°C		
	Phenolic Foam (mm)	Mineral Wool (mm)	Nitrile Rubber (mm)	Phenolic Foam (mm)	Mineral Wool (mm)	Nitrile Rubber (mm)
15	15	25	35	20	40	45
20	15	25	35	20	40	45
25	15	30	40	20	40	50
32	20	30	40	20	50	50
40	20	30	40	25	50	50
50	20	40	50	25	50	60
65	20	40	50	25	50	60
80	20	40	50	30	50	60
100	25	50	60	35	65	75
150	30	60	70	35	70	85
200	30	60	70	40	70	85
250	30	60	70	40	75	90
300	35	60	70	40	75	90
Vessels	35	65	75	45	90	100

NOTE: The thicknesses in Tables 1 and 2 are calculated to provide equal heat loss for each material based on their respective thermal conductivities

TABLE 3 Minimum thickness of insulation required to give protection against freezing under specified commercial and institutional conditions in accordance with BS5422 (REV12-2001) Table 15

Initial Water Temperature		+2 °C			+2°C		
Minimum ambient temperature		-6°C (Indoor unheated areas)			-10°C (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	Nitrile Rubber	Phenolic foam	Mineral Wool	Nitrile Rubber
Copper Pipes							
15,0	13,6	25	80	115	65	400	740
22,0	20,2	15	25	30	20	60	80
28,0	26,2	15	20	19	15	30	35
35,0	32,6	15	20	13	15	20	25
42,0	39,6	15	20	9	15	20	19
54,0	51,6	15	20	6	15	20	13
76,1	73,1	15	20	6	15	20	9
108,0	105,0	15	20	6	15	20	6
Steel Pipes							
21,3	16,0	20	50	65	50	175	265
26,9	21,6	15	25	30	20	60	70
33,7	27,2	15	20	19	15	30	38
42,4	35,9	15	20	13	15	20	25
48,3	41,8	15	20	9	15	20	19
60,3	53,0	15	20	9	15	20	13
76,1	68,8	15	20	6	15	20	9
88,9	80,8	15	20	6	15	20	9

NOTE:

Thicknesses given are calculated specifically against the criteria noted in the table. Adopting these thicknesses may not satisfy other design requirements.

Some of the 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. To provide the appropriate degree of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by using a frost stat, temperature controlled circulation of the water or heat tracing the pipe.

10-14 DUCTWORK INSULATION

Foil faced rigid Phenolic foam slabs or approved equivalent shall be provided for all ductwork in accordance with BS 5422. Where ductwork is external to the building the insulation shall be overlaid with either

- a) Roofing felt, with overlaps not less than 50mm at the joints sealed with adhesive. The whole to be additionally secured by wrapping with 25mm mesh x 1mm thick galvanised wire then painted with two coats of bituminous paint.
- or
- b) Polyisobutylene sheet not less than 0.8mm thick and of tensile strength not less than 3.4 MN/m², lapped and sealed by manufacturers solvent welding fluid.

PART 11

VENTILATION AND AIR-CONDITIONING

11-1 FANS

All fans shall be as detailed in the Schedule of Equipment. All fan motors are to be super silent, and capable of handling the volume of air specified when operating against the specified resistance. Fans shall be adequately supported, either on a concrete base or on a framed metal support structure. All fans are to be mounted on anti-vibration mountings.

11-2 FAN CONNECTIONS

All fans supplied are to be fitted with 'rot proof' flexible joints to connect the fan to both supply and delivery ductwork. These joints shall have a minimum free length of 76mm.

11-3 DAMPERS

Regulating dampers are to be installed into the ductwork where indicated. These shall be Multivane type operating on the opposed blade principle. No individual damper blade shall exceed 225mm height, and provision shall be made for linkage to connect the multiple extended spindles. A suitable indicating and locking device shall be provided on the outside of the damper section.

11-4 FIRE DAMPERS

Fire dampers shall be provided as specified and fixed in accordance with the requirements of the latest Building Regulations and HVCA guide DW/TM3, particularly where ducts pass through walls or floors forming fire barriers, including where a duct passes through a ceiling void fire barrier.

11-5 ACCESS FOR DAMPERS

The Contractor shall fix in the ductwork adjacent to all fire and regulating dampers, a suitably sized access panel for maintenance and checking of the dampers. Panels to be supplied with airtight gaskets, and fixed with wing nuts.

11-6 DUCTWORK

All ductwork shall be fabricated and installed in galvanised sheet steel in accordance with the HVCA publication DW 144 unless otherwise noted.

11-7 SUPPORTS

All ductwork shall be adequately supported by means of sets of hangers with angle iron supports, or as detailed on the drawings, to spaces as detailed in publication DW 144

Note: all supports shall be insulated from the ductwork it is carrying by means of felt strips or other approved material.

11-8 **AIR-CONDITIONING AND REFRIGERATION EQUIPMENT**

- a) Installation of air-conditioning and refrigeration equipment shall be undertaken by an approved specialist sub contractor. All personnel handling refrigerant shall be certified under the current refrigerant handling certification scheme.
- b) Condensate pipework shall be run in white PVC laid to falls the route to be agreed on site with the contract administrator.
- c) Peristaltic condensate pumps shall be included for where required
- d) A clear condensate trap shall be provided for each connection to the drainage system.
- e) Refrigerant pipework shall be in accordance with BS EN 10255, grade as appropriate for the refrigerant type.
- f) Refrigerant pipework and electrical cabling associated with the equipment shall be run on galvanised basket tray over its full length.
- g) Refrigerant pipework shall be thermally insulated with Armaflex insulation in accordance with BS 5422. Where exposed to the elements the Armaflex shall be overclad with solvent welded Polyisobutylene or Isogenopak PVC covering sheet.
- h) Installation and, commissioning and testing generally in accordance with HVCA Guide RAC 80
- i) The air-conditioning specialist shall return to site one month after initial commissioning of the equipment to carry out a leak inspection and operation test.

PART 12

TESTING, COMMISSIONING AND WATER DISINFECTION

12-1 PRESSURE

Upon completion of the installation, all heating and domestic hot and cold water pipework systems shall be thoroughly flushed out with clean water, and subjected to a hydraulic test of 1.5 times the maximum pressure or 3.5 bar (50 psi) whichever is the greater, for a period of 12 hours without loss of pressure. All welds must be hammer tested and remain firm. All pressure tests shall be carried out before the application of thermal insulation and before pipes are concealed or buried, and where this would prejudice the completion of the installation, individual sections of the system shall be tested before applying insulation. All tests shall be witnessed and signed in person by the Contract Administrator or Clerk of Works. Adequate notice shall be given.

Refrigeration pipe work systems shall be pressure tested in accordance with the equipment manufacturers guidance. Refer also generally to HVCA document TR/20.

Gas pipework shall be tested in accordance with standard industry practice, with the test period calculated from the system volume.

Two copies of individually signed Test Certificates shall be submitted to the Contract Administrator for approval.

12-2 COMBUSTION

Following the tests specified, the Contractor shall arrange for the combustion efficiency tests to be carried out on the boiler plants, all burners shall be commissioned by the Engineer employed by the burner or boiler manufacturer. On all gas fired plants the gas rate of the equipment is to be checked and recorded, and confirmed as being suitable for the burner.

Two copies of the combustion efficiency test report must be submitted to the Contract Administrator.

12-3 GENERAL OPERATIONAL TESTING

A normal working test shall be carried out with the plant operating at its designed working pressure, and temperature. During this test, all necessary adjustments to regulation valves or dampers shall be effected. Two copies of the balancing test certificate or drawings shall be submitted to the Contract Administrator.

Any defects of workmanship, materials and/or any maladjustments or irregularities which become apparent during the test, shall be rectified by the Contractor, and the test repeated at the Contractor's expense, to the satisfaction of the Contract Administrator.

The Contractor shall supply all labour, apparatus, and instruments for carrying out the tests. The accuracy of the Contractor's instruments shall be demonstrated.

The provision of water, gas, and electricity, for such tests is not the responsibility of the Contractor on all contracts let on existing buildings.

The Contractor shall give 48 hours notice of all site tests to the Contract Administrator.

During the defects liability period, any defect which effects the efficient operation of any system shall be rectified immediately by the Contractor. In the event that no immediate response occurs, the Contract Administrator reserves the right to call in another Contractor and deduct the costs from the retention.

All commissioning shall be undertaken during the contract period and reports and certificates on all systems forwarded to the engineer for approval in good time so that any anomalies or problems can be remedied without delaying practical completion.

12-4 MEDIUM AND LOW PRESSURE HOT WATER HEATING

When all connections are completed, the pipework systems shall be performance tested in accordance with CIBSE commissioning Code series 'W'. Where heat producing plant are contained within the Sub-Contract these shall be commissioned in accordance with CIBSE code series 'B'.

Commissioning and Performance Tests

After commissioning of all items of plant all circuits shall be regulated and balanced to obtain design flow conditions.

After regulating of the system has been carried out performance tests shall be undertaken and the following recordings obtained:

- (a) Room temperature
- (b) Boiler or calorifier flow and return temperatures
- (c) Outside weather temperature
- (d) Sub-circuit flow and return temperatures where required by the Contract Administrator
- (e) All water pump speeds, duties and pressures

The above recorded temperatures shall be taken hourly for a period to be decided by the Contract Administrator.

The results of the tests shall be recorded in the manner prescribed by the Contract Administrator and triplicate copies handed over to him for acceptance, and included in the Operation and Maintenance Manuals.

12-5 DOMESTIC HOT WATER SUPPLY

When all connections are complete and all plant has been commissioned, the pipework distribution shall be balanced and performance tested in accordance with CIBSE Commissioning Code series 'W'. Tables indicating every mixing valve location and setting as well as every hot water return and recorded temperature shall be produced. Where alterations to existing hot water circulation systems are undertaken, the whole of the existing circulation system shall be balanced and the results tabulated, unless the project specification calls for local balancing, in which case the affected legs shall be set and recorded to maintain a 4-6 degree temperature differential between flow and return.

12-6 COLD WATER SERVICES

When all connections are complete, the pipework shall be balanced, regulated and performance tested in accordance with CIBSE Commissioning Code series 'W'.

All taps, showers, ball valves and outlets shall be opened and checked for satisfactory flow. Outlet flow volume checks shall be performed on a timed basis at the direction of the Contract Administrator and record copies of the results shall be handed to him and included in the Operating and Maintenance Manuals.

12-7 WATERMARK CERTIFICATION

On completion of the domestic water services installation the contractor shall complete the Watermark Self Certification Certificate. The contractor shall forward a copy to the applicable water authority and provide a copy for the Operating and Maintenance manual.

WaterMark Approved Contractor Scheme

Certificate of Self Certification of the Water Supply (Water Fittings) Regulations 1999

Name of installer (Print)

Name of Company

Name and address of property where work has been undertaken

Brief description of work undertaken

I certify that the plumbing work undertaken by myself complies with the requirements of the Water Supply (Water Fittings) Regulations 1999

Signed _____ Date _____

Copy must be provided to the Customer and to the Water Regulations Department STW PO Box 51 Raynesway Derby DE21 7JA (See Regulation 5 (1) and Regulation 6)



12-8 VENTILATION AND AIR CONDITIONING INSTALLATION

General

The Sub-Contractor shall test all specialist equipment, fan, filters, washers, all heaters and coolers, etc., as determined by the Contract Administrator to the relevant CIBSE commissioning Code series 'A' and 'R'.

Prior to commissioning, all dust and other materials shall be removed from the ductwork with grilles and specialist equipment removed from the ducting. If necessary the Sub-Contractor shall demonstrate to the Contract Administrator that the system has been adequately cleaned by dismantling sections of the ductwork or provide inspection holes as deemed necessary by the Contract Administrator.

Prior to commissioning all filters, air heaters and coolers, specialists equipment, grilles, etc., shall be thoroughly cleaned to the satisfaction of the Contract Administrator.

The Sub-Contractor shall test all low velocity air distribution equipment as determined by the Contract Administrator in accordance with CIBSE commissioning Code 'A'.

The Sub-Contractor shall test all refrigeration equipment as determined by the Contract Administrator in accordance with CIBSE commissioning Code 'R'.

12-9 AUTOMATIC CONTROLS

All automatic controls, panels, and associated equipment shall be commissioned by the Contractor in accordance with the details included in Part 8 of this specification and the CIBSE commissioning code series 'C'.

12-10 ELECTRIC WIRING AND EQUIPMENT

The Sub-Contractor shall be responsible for ensuring that all electrical equipment and internal wiring or wiring forming an integral part of mechanical equipment and part of the Mechanical Engineering Contract shall be tested in accordance with I.E.E. Regulations, latest edition, in the presence of the Contract Administrator.

A copy of completion and test certificates as obtained from the NICEIC or ECA shall be submitted to the Contract Administrator.

12.11 DISINFECTION OF POTABLE WATER SYSTEMS USING STABILISED CHLORINE DIOXIDE

(1) General

- (a) The disinfection of water systems using chlorine dioxide must be carried out by a specialist sub-contractor engaged for the purpose, in compliance with the requirements of BS 6700, HSE ACoP L8 and the Council's Water Quality Policy. The specialist sub-contractor shall preferably be one of the Council's currently-approved Legionella Risk Assessment contractors.
- (b) During the cleaning and disinfecting operation, all specialist sub-contractors and their staff must comply with any operational and safety requirements.
- (c) The specialist sub-contractor must ensure that all staff are fully equipped and trained in accordance with the Health and Safety at Work Act 1974, and appropriate Codes of Practice. At no time must the specialist sub-contractor or his staff put other occupants of the building or employees at risk through non compliance with the Health and Safety at Work Act 1974 or any other regulations, e.g. COSHH regulations etc.

- (d) Prior to the specialist sub-contractor leaving the premises a final clearance certificate must be left with the person in charge of the premises, as to completion of the contract work and clearance of the water supply of all disinfectant.
- (e) All shower heads, spray taps and other tap outlets must be de-scaled and cleansed where necessary, and disinfected.
- (f) Following the cleaning and disinfection, bacteriological and chemical samples will be taken by the specialist sub-contractor. These will be sent by the specialist sub-contractor for analysis by a UKAS-accredited laboratory for all bacteriological and chemical parameters deemed necessary. This will include TVCs and coliforms, but where specified or requested by the Contract Administrator a Legionella sample will be required.
- (g) All sampling and testing will be carried out in accordance with UKAS accreditation procedures. Samples will be required from a minimum of two hot and two cold water taps, including where applicable (1) existing hot and cold water system, (2) nearest sentinel hot and cold water taps, and (3) most distant sentinel hot and cold water taps. Where the size and complexity of the installation warrants, or where the Contract Administrator deems that the risk assessment or analysis results call for further samples, additional samples shall be taken and analysed, up to a maximum of 10% of installed draw-off points.

(2) CERTIFICATION

Handover will not be accepted unless the following certification is available:

- (1) Certificate of disinfection issued by specialist sub-contractor
- (2) Certificate of analysis of water samples confirming satisfactory water quality, including zero (0) coliform or E. Coli organisms
- (3) Where specified, certificate of analysis of water samples confirming concentration of Legionella bacteria below measurable limits

Version control sheet

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2010.01	05.05.2010	Version control sheet incorporated. Clause 4.3 amended to prohibit flexible hoses in potable water systems.	P Harris
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