1 MECHANICAL & PUBLIC HEALTH SERVICES MATERIALS AND WORKMANSHIP

1.1 Materials and Workmanship Generally

1.1.1 Unless stated otherwise, all equipment, materials and areas of workmanship covered by BS or CP or other approved standards, whether detailed in this Specification or not, shall comply with their requirements.

1.1.2 All materials and equipment utilised shall be installed in strict accordance with the manufacturer's recommendations. Where owing to site conditions materials cannot be installed in accordance with the manufacturer's recommendations, the Contractor shall notify the Contract Administrator prior to commencement of installation.

1.1.3 All workmanship shall be subject to the approval of the Contract Administrator.

1.1.4 The Contract Administrator reserves the right to reject any part of the installation not complying with this Specification and/or the Contract Drawings, and the Contractor shall carry out the necessary remedial work or replacement free of charge and without delay to the Contract.

1.1.5 No approval or any acceptance by the Contract Administrator shall relieve the Contractor of their responsibilities under the Contract for the quality of materials and the standard of workmanship of the works.

1.1.6 Where material manufacturers and/or catalogue numbers are specified they shall be strictly adhered to. In the event of discontinuation of such materials or companies the Contractor shall notify the Contract Administrator who will specify an alternative.

1.1.7 All materials used in the installation shall be marked as appropriate with the UKCA Marking to show compliance. Certificates of conformity shall be obtained from the Suppliers and these shall be incorporated in the O&M Manuals.

1.1.8 Where specific British Standards are referred to herein these shall be deemed to refer to the current edition of such Standard and shall include as far as practicable any amended Standard requirements which may become current before the date at which the work is carried out.

1.1.9 No substitution for specified or approved materials will be permitted except by permission of the Contract Administrator in writing.

1.2 Sizes of Plant and Equipment

1.2.1 The duties and ratings of fans, pumps, etc. described in this Specification and on the Contract Drawings are the minimum necessary for the operation of the complete systems. The Contractor shall be responsible for checking the duties against the working drawings and for making all necessary adjustments to achieve the design performance.

1.2.2 The Contractor shall be responsible for obtaining plant and equipment selections from the selected manufacturers which fall within the middle of the range of the plants performance and not at the maximum or minimum capabilities.

1.2.3 The Contractor shall submit details of the plant selections to the Contract Administrator for approval prior to manufacture (or delivery, for "off the shelf" items).

1.3 Suitability for Site Conditions

1.3.1 All materials and equipment installed shall be suitable in all respects for the site conditions, in terms of both climate and conditions in which the items are to be installed and also in terms of the specific location on site.

1.4 Protection, Painting and Galvanising

1.4.1 Unless noted otherwise elsewhere in this Specification, all cut ends of galvanised steelwork (pipework, steelwork, support systems, etc.) shall be treated as detailed within this clause. Scratches and other damage to galvanised finishes shall also be repaired as described below, provided that such repairs have been previously agreed with the Contract Administrator.

1.4.2 All exposed, unfinished steelwork (such as threads on pipework systems) shall also be treated as described below. In all cases, cut ends shall be filed and /or reamed to remove burrs, swarfe and sharp edges to give a smooth finish. Any rust or other surface scaling shall be completely removed and where necessary a degreasing solution shall be applied.

1.4.3 A cold galvanising treatment shall be applied over the entire area of exposed metal, overlapping the surrounding sound galvanised finish by not less than 25mm.

1.4.4 All pipes and iron-work to be painted shall first be prepared in accordance with the paint manufacturers recommendations, including all necessary rubbing down, de-greasing, priming, etc. Un-insulated non-ferrous valve bodies shall be thoroughly cleaned and left unpainted.

1.4.5 All black steel pipework, steel hangers, brackets, supports, gantries, anchors, guides, etc. provided and erected under this contract shall be painted with one primer coat of zinc phosphate after erection.

1.4.6 On completion, all exposed piping in plantrooms, risers and similar spaces, together with brackets, flanges, etc., shall be painted with two further coats of heat resistant paint to a colour approved by the Contract Administrator.

1.4.7 All welds in steel mains, brackets, etc. throughout shall be wire brushed and the weld given one coat of zinc phosphate primer for 250 mm either side of the weld, a maximum 1 hour after welding.

1.4.8 Hot and cold pulled sets, etc. shall be wire-brushed, and given one coat of zinc phosphate primer.

1.4.9 All plant and equipment, control panels and other specialist items shall be delivered to site with a factory finish in accordance with the detailed requirements of this Specification. All finishes shall be protected once delivered to site to maintain the factory-applied finish at Practical Completion.

1.4.10 All on-site painting works shall be covered by a detailed method statement, to the approval of the Contract Administrator. The method statement shall include the following items:

1.4.11 The production and issuing to the Contract Administrator of a comprehensive risk assessment, covering environmental and Health and Safety aspects of the proposed work.

1.4.12 The undertaking of a COSHH assessment of all proposed materials.

1.4.13 Preparation of galvanised surface of ductwork sections, channel support systems etc., with an etching primer to ensure adhesion of paint to surfaces.

1.4.14 Preparation of items to be painted in accordance with manufacturers recommendations, with particular reference to the suitability of surroundings.

1.4.15 Application of undercoat paint with brush/roller over all external faces of ductwork, flanges and supports, and storage while paint is allowed to cure.

1.4.16 Application of a top-coat of coloured, chlorinated rubber paint to ductwork, flanges and supports, in accordance with manufacturers' recommendations, and storage while the paint is allowed to cure.

1.4.17 Application of further top-coats to the previous coloured chlorinated rubber paint, as detailed above.

1.5 Installation of Apparatus and Fixings

1.5.1 Wherever possible, equipment shall be fixed using roundhead sherardised woodscrews and plastic raw plugs. Such screws shall be of the largest size admitted by the fixing holes of the equipment and shall be of sufficient length to secure the item to the approval of the Contract Administrator.

1.5.2 Unless otherwise indicated elsewhere in the Specification no item shall be fixed with less than 2 No screws.

1.5.3 Where necessary due to the nature of the building fabric, spring toggles or expanding anchors may be used, with sizes and dispositions generally as described above.

1.5.4 In concrete and similar materials, rawl-bolts and similar devices shall be used for fixings in excess of 6mm diameter. They shall sherardised and shall incorporate a washer and hexagon head drive.

1.5.5 Shot-fired and chemical or thermal welding systems shall only be used with the expressed permission of the Contract Administrator.

1.5.6 Where suitable structural steelwork exists, it shall be generally acceptable to employ knock-on type clips, but the Contractor shall gain approval for their use from the Contract Administrator prior to commencement.

1.5.7 Under no circumstances shall any structural steelwork be fixed to or modified in any way without the prior approval of the Contract Administrator.

1.5.8 All support bracketry shall be constructed from a preparatory system of pre-galvanised mild steel channel to BS EN 10162 and BS 2898/BS EN 755. Accessories shall be of 6mm (minimum) hot-dip galvanised BS EN ISO 1461 mild steel and all supports shall provide a load factor of 1.6 in accordance with BS 5950: Part 5.

1.5.9 All cut ends shall be treated with a cold galvanising agent as described elsewhere in this Specification. They shall be cut square, shall be filed smooth to remove all burrs, and shall be fitted with blue uPVC end caps.

1.5.10 Generally, fixing and suspension systems shall be of galvanised steel channel, angle or drop rod, as detailed elsewhere in this Specification or on the Contract Drawings. The type of fixing shall be detailed on the Contractor's Installation Drawings, and shall be subject to the approval of the Contract Administrator.

1.5.11 Facilities shall be incorporated into all suspension systems to take up building tolerances. Where the structure is of hollow pot construction, fixings shall not be made into the floor pots, and shall only be made into ribs between the pots with the detailed approval of the Contract Administrator.

1.5.12 All services and associated fixings shall be coordinated with the specialist ceiling Contractor's fixing arrangements. The Contractor shall provide all necessary bridging pieces between fixing supports.

1.5.13 Fixings shall not be made to areas where "waterproofed" concrete or other procedures have been incorporated to prevent water penetration. In such areas free standing 'goal post' - type supports shall be used.

1.5.14 Similarly, 'goal post' supports shall be used to carry plant and other services where roof structures are not specifically designed to carry the associated loads.

1.5.15 The Contractor shall design, supply and install a secondary support system within riser shafts to support services.

1.6 Use of Dissimilar Metals

1.6.1 The Contractor shall ensure that no part of any mechanical services system comes into contact, or close proximity, with another material such that shall they promote a chemical or electro-chemical action.

1.6.2 This requirement shall apply to all pipe surfaces, fittings, valves, plant, vessels, pumps, ductwork, and any other items of equipment in the installation. Should it be impossible to install passive materials, correct water treatment shall be provided to prevent dissimilar metal interaction.

1.7 Oil and Greases

1.7.1 The Contractor shall provide and install the initial charge of all oils or greases for lubrication points on all items of equipment supplied under this Contract. All valve and gland packings and shall include for any necessary following-up and topping-up, to ensure that the correct levels and conditions are maintained both at Practical Completion, and throughout the defects liability period.

1.8 Protection Guards

1.8.1 The Contractor shall ensure that the suppliers of all equipment used on the contract provide safety guards as required by the Health and Safety at Work Act. The correct installation of all such items shall be the responsibility of the Contractor.

1.8.2 Moving parts of all machines such as fans, pumps, etc. shall be protected by wire mesh guards to the satisfaction of the Contract Administrator and to the requirements of the Factory Inspector.

1.8.3 All machine guards shall comply in all respects with the edition of current Health and Safety at Work Act. They shall be constructed from solid or perforated sheet metal or wire mesh in an iron frame, all galvanised after manufacture, and shall be so designed with hinges and/or removable sections as to allow for routine testing and maintenance.

1.8.4 All guards shall be free from vibration and shall fully enclose the relevant drive.

1.9 Labels

1.9.1 The Contractor shall supply and fix brass or traffolyte disc labels to all equipment and valves on mains and sub-circuits to facilitate their ready identification.

1.9.2 Valve labels shall be of brass or rigid plastic with engraved lettering, filled with an approved coloured composition to provide a clear indication. The functions and positions of all regulating valves shall be indicated by means of an additional label. All labels shall be affixed in positions and in a manner to the approval of the Contract Administrator. Generally, corrosion resistant chain shall be used for this purpose.

1.9.3 Each valve label shall be numbered to coincide with a schedule of valves, etc. prepared by the Contractor as part of his record drawings package. The valve chart shall be printed on laminated card or fitted into a glazed frame, and permanently fixed to the associated plantroom wall in a prominent position.

1.9.4 Each calorifier, pump, fan, etc. shall be provided with a manufacturers' label, permanently fixed to the equipment, giving the following information:

- Plant schedule reference number. Manufacturers' serial number. Date of manufacture
- Rated duty of equipment
- Test and working pressures
- Horse power Speed Amperage
- Voltage and phases

1.9.5 Any other details as may be appropriate to the item of plant so that it may be readily identified at a later date.

1.9.6 Labels shall be permanently fixed to the approval of the Contract Administrator, and shall be of suitable dimensions for the particular item of equipment to which they refer.

1.10 Fire Resistance

1.10.1 All the materials used in connection with or as part of the installation shall be incapable of spontaneous combustion, shall not support combustion once ignited, shall be self- extinguishing, and shall comply with Local Authority, Fire Brigade and all other regulations.

1.11 Fire Hazard

1.11.1 The Contractor shall be responsible for ensuring that proper precautions are taken to protect the building and its contents where naked flames, electric arcs, etc. are used in the course of the installation, commissioning or testing of the works.

1.11.2 All such works shall be subject to the approval of the Contract Administrator, as detailed elsewhere in this Specification. Fully detailed method statements shall be provided for all proposed hot working.

1.11.3 The Contractor shall ensure that the correct types of fire extinguishers are in place prior to commencement of works, in areas where such hazards exist. A Permit to Work system shall be employed for all hot working, as detailed elsewhere in this Specification.

1.12 Hot Working Permit

1.12.1 All welding, soldering, brazing or other hot working methods used must be notified to the Contract Administrator and a hot working permit obtained. Such a permit will be issued in respect of all hot working to cover specific aspects of work over specific periods only.

1.12.2 The Contract Administrator reserves the right to remove from site any persons working without due care or without necessary permits to work.

1.13 Holding Down Bolts

1.13.1 The Contractor shall provide and install all holding down bolts and nuts necessary for the fixing of the equipment supplied in this Contract. The Contractor shall be responsible for providing all necessary detailed working drawings indicating exact positions of holes for accommodating bolts, and for checking on site that the holes are provided in the required positions.

1.13.2 Holding down bolts open to the weather shall be of galvanised steel or other approved non-rusting material.

1.14 Frost Damage

1.14.1 The Contractor shall be held responsible, until Practical Completion is granted, for any damage caused as a result of frost to the works covered by this Contract.

1.14.2 The Contractor shall drain all sections of unprotected pipework containing water, whenever the ambient temperature falls below 4°C. All draining down and refilling necessary for compliance with this Clause shall be carried out without additional charge or delay to the Contract.

1.15 Pipework

1.15.1 General

1.15.2 All pipework shall be supplied and installed as detailed in this Specification and as shown on the Contract Drawings.

1.15.3 All pipework shall be suitable for the operational fluids, pressures and temperature ranges of the systems in every respect.

1.15.4 All pipework shall be installed with a continuous gradient to allow air venting and drainage. All vertical pipes shall be plumb, and all routes shall be parallel to building lines.

1.15.5 Unless detailed otherwise elsewhere in this Specification or on the Contract Drawings, all steel pipework of 15 to 50mm diameter shall have screwed joints. Pipework of larger sizes shall have welded/flanged joints.

1.15.6 Pipework located within fully accessible mechanical risers may optionally have mechanical joints, where agreed by the Contract Administrator. A suitable clearance, after insulation, between the insulation and any other objects including walls, floors, ceilings, pipes or any other surfaces shall be maintained at all times.

1.15.7 All cut ends and screwed fittings on galvanised pipework shall be filed to remove burrs and treated with a cold galvanising agent immediately on completion, as detailed elsewhere in this Specification.

1.15.8 The Contractor shall ensure that all pipework tubes are free from internal obstructions, and that all open ends are protected by plastic caps during storage and installation.

1.15.9 All pipework shall be free of rust, scaling and pitting.

1.16 Standards

1.16.1 Pipework shall be manufactured and installed in compliance with the following standards: Heavy gauge mild steel, of sizes15 to 150mm shall comply with BS 1387.

1.16.2 Heavy gauge mild steel, of sizes 200 mm and above shall comply with BS EN 10162, Grade 430.

1.16.3 Heavy gauge mild steel accessories with either screwed ends to BS21, taper thread, plain ends, or grooved ends.

1.16.4 Heavy gauge galvanised steel, of sizes 15 to 150 mm shall comply with BS 1387.

1.16.5 Heavy gauge galvanised steel, of sizes 200mm and above shall comply with BS EN

1.16.6 10162, Grade 430.

1.16.7 Heavy gauge galvanised steel accessories with either screwed ends to BS 21, taper thread, plain ends, or grooved ends.

1.16.8 Copper, of sizes 15mm to 159 mm shall be kite marked and shall comply with BS EN 1057 R250 (Class X), with plain ends.

1.16.9 Copper pipework to be buried underground shall be kite marked and to comply with BS EN 1057, with plain ends.

1.17 Hydraulic Pipework Testing

1.17.1 The Contractor shall submit a method statement to the Contract Administrator for approval, prior to commencement of pressure testing.

1.17.2 All pipework systems shall be pressure tested to 6 bar gauge or twice the working pressure, whichever is the greater.

1.17.3 The Contractor shall provide either permanent or temporary bypasses around all terminals, radiators, control valves, plant, etc. suitable for the test pressure specified. All bypasses shall be retained until system flushing has been completed.

1.17.4 Where progress of the works involves piped services being covered in risers, duct, ceiling voids, etc., prior to completion of the total installation, then sectional pressure tests shall be carried out.

1.17.5 All pre-fabricated pipework shall be tested at the manufacturer's works. The Contractor shall cover all costs associated with the Contract Administrator's factory witness testing of all such systems.

1.18 Pipework Schedule

1.18.1 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, all pipework shall be installed in accordance with the following schedule.

System	Area	Material
LPHW/CHW 15mm - 150mm	Plantrooms/Risers Service Voids	Black Mild Steel BS: 1387 Heavy Duty or Stainless Steel
15mm - 100mm	Plantroom	BS EN 1057 R250 (Class X) Copper or Stainless Steel
Gas	Above Ground	Steel to BS: 1387 Heavy Weight

1.19 Pipework Fittings

1.19.1 Steel Pipework and Fittings

1.19.2 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, all pipework systems shall comply with the following:

- All steel pipework of sizes 15 to 50mm shall have screwed joints.
- All steel pipework of sizes 65mm and above shall have welded/flanged joints. Pipework located in fully accessible risers may optionally have mechanical joints. All pipework in ceiling voids shall be of fully welded construction
- All pipework fittings of sizes 15 to 150mm shall utilise steel fittings in compliance with BS 1387.
- All screwed joints shall comply with BS 21.
- All screwed and welded flanges shall comply with BS EN 1092-2, with PN rating to suit the application.

- All flange jointing rings shall be compatible with flanges to BS EN 1092-2, and shall be of the standard type as detailed in BS EN 1514-1.
- All union connections shall be of the malleable iron navy pattern, with bronze to bronze spherical seats. They shall only be installed in accessible locations, to the approval of the Contract Administrator.
- Where welded joints are used, welding rods shall comply with BS 1453 types A2 or A3 for gas welding, and BS2633 or BS2971 for electric arc welding.
- Eccentric type reducers and enlargements sockets, tees, bends etc. shall only be installed on horizontal runs to facilitate air venting and drainage. Bends and swept tees shall be used wherever possible.
- Bushes and square elbows shall not be used, and square tees may only be used at air venting and drainage points.

1.20 Large Size Steel Pipework

1.20.1 For pipework fittings of 200mm and above all steel fittings shall comply with BS 1965 part 1/BS EN 10253-1, complete with bevelled ends for butt welding.

1.21 Galvanised Mild Steel Pipework

1.21.1 All pipework and fittings shall comply with BS 1387. All pipework and fittings shall be galvanised.

1.21.2 Machine made or pulled bends shall not be permitted on galvanised pipework, unless the pipework is to be galvanised after manufacture.

1.22 Copper Pipework

1.22.1 All capillary fittings for copper pipework shall comply with BS 864 part 2/ BS EN 1254 Parts 1 and 2.

1.22.2 All copper fittings shall be kite marked, and to be of copper (non–dezincifiable) material. For copper pipework of sizes 15 to 54 mm nominal bore, all fittings shall be of the capillary type.

1.22.3 For copper pipework of sizes 67mm and above, all fittings shall be silver soldered to BS EN 29453.

1.22.4 All capillary fittings shall be cleaned of flux, excess solder, etc. immediately on completion.

1.22.5 All joints shall be completed in accordance with manufacturer's instructions.

1.23 Refrigeration Quality Copper Pipework

1.23.1 All fittings shall be kite marked, and to be of copper (non–dezincifiable) material.

1.23.2 All joints shall be brazed in accordance with BS 1723. A silver brazing filler alloy suitable for the application shall be used.

1.23.3 Changes in direction of lines run in half-hard pipe shall be made by long-radius bends. All bends in soft pipe shall be made with spring benders.

1.24 Mechanical Joints & Fittings

1.24.1 Where agreed with the Contract Administrator, mechanical joints may be used for the jointing of steel pipework on fully accessible vertical service risers only, in lieu of flanges or screwed/welded joints. Mechanical joints shall not be permitted for vertical pipes in ducts within office floor areas.

1.24.2 Mechanical joints and sealing gaskets shall be suitable for the fluid medium, operating temperature and pressures of the application.

1.24.3 When laying out pipework runs, a degree of angular deflection, contraction and expansion shall be allowed for in accordance with the manufacturer's recommendations. The manufacturer's recommendations shall be strictly adhered to with regard to the requirements for assembly, installation, supports, guides and anchoring of pipework incorporating the mechanical joints.

1.24.4 All coupling units shall be of the rigid type, and shall comply to BS EN 10025.

1.24.5 Electrical continuity clips to meet the current edition of the IEE Regulations BS 7671 shall be used to ensure earth continuity through pipework systems for bonding purposes.

1.24.6 The Contractor shall submit to the Contract Administrator written confirmation of the manufacturers' acceptance of the complete installation.

1.25 Welding of Pipework and Supports

1.25.1 General Requirements

1.25.2 All welding operations shall be carried out in accordance with the recommendations contained in the Health and Safety at Work. The Contractor shall ensure that sufficient ventilation is provided to areas where welding is being carried out to protect the operatives, especially in confined and enclosed spaces.

1.26 Certification of Competence

1.26.1 All welders shall be skilled craftsmen, and shall be in possession of a current "Certificate of Competence" appropriate to the type and class of welding operations to be carried out.

1.26.2 Specimen welds shall be submitted by each welder, and shall be representative of the joints and conditions of site welding for non-destructive testing to comply with BS 2640 or BS 2971. They shall be carried out in the presence of an inspector as required by the Contract Administrator.

1.26.3 Any operatives not judged to meet the required standard shall be replaced by the Contractor, immediately and without delay or cost to the Contract.

1.26.4 A schedule detailing the welder's name, detail of certification, qualification and identification number shall be submitted to the Contract Administrator before welding operation commences.

1.26.5 Each qualified welder shall have a numbered stamp or tags, which shall be used adjacent to the weld in both on and off-site work for identification purposes.

1.27 Welded Joints for Steel Pipes

1.27.1 All preparation, making and sealing for oxyacetylene welding shall conform to BS 1821 or BS 2640, as appropriate to the system operating temperature and pressures.

1.27.2 All preparation, making and sealing for electric arc welding shall conform to BS 2633 or BS 297, as appropriate to the system operating temperatures and pressures.

1.27.3 An electric arc process shall be used for all welded joints on pipework greater than 100mm in diameter.

1.27.4 All pipe ends shall be site prepared to match.

1.27.5 Welding filler materials shall be protected from excessive moisture change in storage.

1.27.6 All welded joints shall be of the butt type except at flanges, where adequate fillet welds shall be provided at neck and bore of plain or slip-on flanges.

1.27.7 Pipe alignment shall be maintained by the use of mechanical means or by tack welds, which shall be either fused into the final weld or ground out. Butt welds shall be finished smooth, thoroughly wire brushed on completion and immediately sealed with one coat of red oxide paint.

1.27.8 In the preparation of welding branches, the welder shall ensure that the cut-out in the wall of the main pipe is of the correct size and shape to suit the swept or square branch connection as appropriate.

1.27.9 All welded joints shall be completed within the working day and in no case shall a joint be left partly completed overnight.

1.28 Supports Welding

1.28.1 Welding of mild steel for supports and brackets for pipework, plant and equipment shall conform to BS EN 1011 Parts 1 and 2.

1.28.2 All welds shall be finished smooth, thoroughly wire brushed on completion and sealed with one coat of red oxide paint.

1.29 Inspection and Testing

1.29.1 The Contractor shall allow for 10% of all butt welded joints and 5% of all other joints selected at random by the Contract Administrator to be subjected to non- destructive testing. Further samples and tests shall be required if any of the initial batch fail to meet the required standards.

1.29.2 The inspection and testing shall be carried out by an independent inspecting authority, on behalf of the Contract Administrator but with all expenses carried by the Contractor.

1.30 Pipe Supports

1.30.1 All pipework shall be supported by brackets, hangers or clips of approved type which are compatible with the pipeline material and meet the detailed requirements of this Specification. The supports shall be arranged to ensure that no undue strain is imposed on the pipework.

1.30.2 Pipework shall be supported guided and anchored so as to allow free movement for expansion and contraction.

1.30.3 All pipework supports shall be detailed on the working drawings.

1.30.4 Pipe supports shall be positioned at the following maximum intervals given in the following tables:

1.31 Steel Pipework

Nominal Bore	Horizontal Pipe	Vertical Pipe
15mm	1.80m	2.40m
20mm	2.40m	3.00m
25mm	2.40m	3.00m
32mm	2.70m	3.00m
40mm	3.00m	3.60m
50mm	3.00m	3.60m
65mm	3.70m	4.60m
80mm	3.70m	4.60m
100mm	3.70m	4.60m
125mm	3.70m	5.40m
150mm	4.50m	5.40m
200mm	5.00m	6.00m
250mm	5.00m	6.00m
300mm	6.10m	10.00m

1.32 Copper Pipework

Nominal Bore	Horizontal Pipe	Vertical Pipe
15mm	1.20m	1.80m
22mm	1.40m	2.10m
28mm	1.80m	2.40m
35mm	2.40m	3.00m
42mm	2.40m	3.00m
54mm	2.70m	3.00m
67mm	3.00m	3.60m
76mm	3.00m	3.60m
108mm	3.00m	3.60m
133mm	3.00m	3.60m
159mm	3.00m	4.20m

1.32.1 Where multiple pipework runs of different bores are supported from a common point, the supports shall be spaced in accordance with the pipe requiring the closest spacing.

1.32.2 For steel tubing, clips shall be fabricated from malleable iron. For copper tubing, clips shall be fabricated from brass, copper or gunmetal. Standard pattern pipe brackets shall be galvanised when used with galvanised piping.

1.32.3 Supporting brackets may comprise purpose-made welded steel brackets, mild steel drop rods from floor plates or surface-mounted angle or channel iron and patent pipe clips, as appropriate. All bracketry methods shall be subject to the approval of the Contract Administrator.

1.32.4 For single pipes, support rods shall be as follows:

Pipe Size	Rod Diameter
15mm – 25mm	6mm
32mm – 80mm	10mm
100mm – 150mm	12mm
200mm – 250mm	16mm
300mm	20mm

1.32.5 Where dual pipe supports are proposed, the Contractor shall ensure that drop rods are adequately sized.

1.32.6 The Contractor shall be responsible for supply and erection of all supports, brackets and hangers.

1.32.7 Vertical rising pipes shall be supported at the base to withstand the total weight of the riser. Branches from risers shall not be used as a support for the riser.

1.32.8 Pump suction and discharge pipework shall be supported to ensure that the pump pipework connections do not carry the weight of the connecting pipework under operating conditions.

1.33 Pipe Sleeves

1.33.1 All pipework passing through building elements (walls, floors and partitions, etc.) shall pass concentrically within purpose made sleeves.

1.33.2 Pipework sleeves shall be cut from the same pipework material that passes through the sleeve. The sizes of the sleeve shall be one or two sizes larger than the pipework, or pipework and insulation where the insulation is carried through.

1.33.3 Pipework sleeves shall not be used as pipe supports.

1.33.4 All sleeves built into walls or floors shall finish not less than 2 mm proud of the finished face.

1.33.5 The annular space between the pipes and sleeves shall be a packed with mineral wool or similar non-flammable and fire resistant material to form a fire/smoke seal of the required rating. Both ends shall be sealed with 12mm deep mastic seal.

1.33.6 Where pipes pass through trench covers, special flanged sleeves shall be provided to form a water-tight seal.

1.33.7 Pipes that rise through the floor of the plant areas, retaining walls, etc. where a waterproof membrane is applied shall be routed via puddle flange type sleeves, tightly caulked, and shall extend a minimum of 100mm above beyond the finished level.

1.33.8 The Contractor shall build in all sleeves, and shall be responsible for ensuring that the sleeves are correctly positioned.

1.34 Wall and Floor Plates

1.34.1 Pipework passing through building elements (walls, floors, partitions and ceilings) exposed to view shall be fitted with heavy split type copper alloy chromium plated steel wall or floor plates.

1.34.2 The plates shall be fitted closely to the building surface and shall provide a neat finished appearance. The fixings shall be chrome raised head fixing screws.

1.35 Provision for Thermal Movement and Anchor Guides

1.35.1 Provision for expansion and contraction of pipework caused by thermal changes shall generally be accommodated at changes in direction of pipework. Supports and fixings shall be installed to accommodate the pipework movement.

1.35.2 Expansion and contraction movement shall be catered for at all branch connections. Where such methods are not practical, expansion bellows to suit the application shall be supplied and installed. The bellows shall be stainless steel, multi ply construction with stainless steel inner sleeves. Bellows expansion joints shall be screwed to BS 21, flanged to BS EN 1092-2 or bevelled for welding, to suit the pipework installation.

1.35.3 All expansion bellows shall be of a material construction suitable for the operating medium being conveyed, and system pressures and temperatures. They shall be able to withstand the system test pressure without deformation.

1.35.4 All bellows shall be installed strictly in accordance with the manufacturer's recommendations.

1.35.5 Short branches of pipework shall be dog-legged to reduce the stress imposed by the thermal changes in pipework.

1.35.6 Quantities and positions of anchors and expansion bellows shown on Contract Drawings are indicative. The Contractor shall ensure adequate provisions is made to suit the installed pipework arrangements, and shall ensure that the positions of all such items are accurately detailed on Record Drawings.

1.35.7 The Sub Contractor shall include supporting calculations with the Technical Submission for expansion provision.

1.36 Anchors

1.36.1 Anchors shall be constructed to resist axial stress transmitted by movement of horizontal and vertical pipe runs and loadings. The Contractor shall submit details of the structural loadings, calculations and proposals from the specialist supplier to the Contract Administrator for review as part of the Technical Submission for expansion provision.

1.36.2 For mild steel pipework, anchors shall be constructed using mild steel over straps or heavy U bolts. The channel section shall be securely fixed to the building structure. The longitudinal edges of the over strap or U bolts shall be welded to the pipework.

1.36.3 For copper pipework, anchors shall comprise wide copper straps to secure the pipework. The Contractor shall supply and fix in position ready for building in all cleats, brackets and steelwork required for anchor points.

1.36.4 The anchor points shall be positioned in accordance with the specialist expansion bellow manufacturer's recommendations.

1.37 Slide Guides

1.37.1 The movement of expansion and contraction imposed from the Anchor points shall be directed to the expansion loops, bellows and flexible inserts. All thrust shall be linear, relative to the axis of the pipe.

1.37.2 Guides shall be generally constructed to BS 3974 Parts 1 and 2. Friction reducing material shall be applied between the metal faces.

1.38 Equipment and Flexible Pipework Connections

1.38.1 All branch connections to items of plant and equipment shall be complete with isolation and commissioning valves.

1.38.2 All such valves shall be provided with flange or union connectors on the "equipment" side, to facilitate drainage, disconnection and removal.

1.39 Flexible Pipework Connectors.

1.39.1 Where detailed elsewhere in this Specification or on the Contract Drawings, flexible terminal unit connectors shall be installed.

1.39.2 Flexible connectors shall be constructed of EDPM inner liners with stainless steel wire braid. Nickel-plated brass fittings with stainless steel ferrules shall be provided connected to the flexible connector.

1.39.3 All connectors shall be pressure tested to a minimum of 6 Bar or twice the working pressure, whichever is the greater.

1.39.4 Hoses shall be capable of resisting kinking when bent through 180 degrees, and maximum the length shall be 300mm unless otherwise detailed elsewhere in this Specification or on the Contract Drawings.

1.39.5 All flexible hose connectors shall be installed to strictly comply with manufacturer's recommendations.

1.40 Floor Void Pipework Connections

1.40.1 Pipework service tails to radiators, etc. in false floor voids shall be located adjacent to floor pedestals, to allow electrical floor outlet boxes to be located in the centre of the tile.

1.40.2 All tails shall have adequate clearance from the floor pedestals to accommodate pipework insulation and thermal expansion of the mains.

1.41 Air Vent and Air Bottles

1.41.1 All pipework shall be installed with gradients, to ensure drainage and/or air release. All pipework, coils and equipment shall incorporate air vents or cocks.

1.42 Manual Air Vents/Bottles

1.42.1 Manual air vents or air bottles shall be provided at all high points in pipework systems to facilitate air release.

1.42.2 Air bottles shall be installed in a vertical extension of the pipework, approximately 150mm long and at the same bore as the pipe. Mild steel or copper extension pipes incorporating manual vent cocks shall be located in accessible positions.

1.42.3 All vent cocks shall be labelled with a black on white traffolyte label identifying the purpose and service, i.e. "Airvent, Primary Heating".

1.43 Automatic Air Vents

1.43.1 Automatic air vents shall be used only where detailed within this Specification or in the Contract Drawings.

1.43.2 AAV's shall be constructed of bronze or DZR copper alloy bodies, with threaded inlet to BS 21. Copper or stainless steel floats and self-closing air release valve shall be incorporated.

1.43.3 Air release extension pipes shall be installed with integral non–return valves to discharge at an accessible visible location, subject to the agreement of the Contract Administrator.

1.43.4 All air vents and release pipes installed in exposed positions shall be insulated and if necessary trace heated to prevent freezing.

1.44 Drainage

1.44.1 All pipework shall be carefully graded to a fall to facilitate complete draining of lines for maintenance purposes, and to assist the flushing process.

1.44.2 Full-bore dirt pockets shall be installed at the bottom of each vertical riser having a vertical height of 5 metres or more. For pipework sizes 25 to 200 mm diameter, dirt pockets shall be not less than 5 diameters distance of pipe. Where pipe diameters exceed 200mm, this requirement shall be 3 diameters distance of pipe.

1.44.3 All dirt pockets shall terminate in a flange and blanking plate. A 25mm lever valve incorporating a hose union shall be provided in the dirt pocket for draining-down purposes.

1.44.4 The Contractor shall demonstrate that all scale/dirt pockets are fully accessible upon completion of the works, to the satisfaction of the Contract Administrator.

1.44.5 Hot Water Service Cylinders and calorifiers shall be provided with key operated gland cocks incorporating hose unions at their lowest points.

1.45 Valves and Cocks

1.45.1 General

1.45.2 All valves and cocks shall be suitable for the operating medium, temperatures and test pressures of the systems into which they are installed, and shall be pressure-tested at the manufacturer's works in accordance with BS 6755. All valves and cocks shall comply with the requirements of the appropriate Water Authorities and British Standards.

1.45.3 Valves shall be installed as detailed elsewhere in this Specification and on the Contract Drawings, and at all places necessary for the proper working, regulation, control and maintenance of the installation.

1.45.4 Valves shall be either screwed to BS 21 or flanged to BS EN 1092-2 PN, rating to suit the application.

1.45.5 Equivalents may be submitted for the approval of the Contract Administrator, but generally all valves on all services shall be as follows:

1.46 Isolating Valves

1.46.1 Isolating valves shall be installed to facilitate isolation of individual or adjacent groups of plant and equipment.

1.47 Ball Valves - Sizes 15 to 50mm inclusive.

1.47.1 Ball valves shall be constructed of brass (excluding chilled water), bronze or DZR copper alloy bodies. The ends shall be screwed to BS 21 or capillary fittings to BS 864 Part 2/BS EN 1254 Parts 1 and 2, as appropriate to the pipework system.

1.47.2 Spheres shall be chrome or nickel plated, with flow aperture. PTFE seats and stem seals with anti-blowout stem shall be provided.

1.47.3 Ball valves shall be lever operated, or incorporate screwdriver or Allen-key operated spindle.

1.48 Flanged Gate Valves - Sizes 65mm and above

1.48.1 Flanged gate valves shall be constructed to BS EN 1171, and shall be of the solid or split wedge type with cast iron body.

1.48.2 Valve seats shall be metal with copper alloy faced trim. The ends shall be to BS EN 1092-2 with PN rating to suit.

1.48.3 All flanged gate valves shall be hand-wheel operated.

1.49 Butterfly Type Valves - Sizes 65mm and above

1.49.1 Butterfly valves shall be constructed to BS EN 593, and shall be of the cast iron body type. They shall have stainless steel shafts, bronze discs and EDPM seat constructions. Controlled elastomer compression shall be provided on flange faces.

1.49.2 Butterfly valves shall be of the semi–lugged wafer type, design for installation between flanged pipework connections. They shall comply with BS EN 1092-2, with PN rating to suit.

1.49.3 Valves to be installed with mechanical joints shall have grooved ends, and all seats shall be bonded.

1.49.4 Butterfly valves shall be either lever and graduated notch plate, wrench or gearbox operated, with long body neck for insulation clearance where used for chilled water systems.

1.50 Regulation and Commissioning Valves

1.50.1 Where detailed elsewhere in this Specification or on the Contract Drawings, valves shall be installed to allow for regulation and commissioning of the water systems for all plant and equipment.

1.50.2 All such valves and devices shall be installed in strict accordance with manufacturer's recommendations.

1.51 Double Regulation Valves – Sizes 15 to 50mm inclusive.

1.51.1 Double Regulation Valves shall be constructed to BS 7350 section 3.1, and shall be of the bronze or DZR copper alloy type with bodies to BS 5154.

1.51.2 Valve ends shall be screwed to BS 21, or flanged to a suitable BS EN 1092-2 PN rating to match the pipework system into which they are installed.

1.51.3 All double regulation valves shall be of the Y type pattern with inside screw rising stem.

1.52 Double Regulation Valves - Sizes 65mm and above

1.52.1 Double regulation valves shall be constructed to BS 7350 section 3.1, and shall be of the cast iron type with bodies to BS EN 13789.

1.52.2 Valve ends shall be flanged to BS EN 1092-2 to a suitable PN rating to match the pipework system into which they are installed.

1.52.3 All double regulation valves shall be of the Y type pattern with copper alloy or nickel alloy valve face and with inside screw rising stem.

1.53 Flow Measurement Devices – Sizes 15 to 50 mm inclusive

1.53.1 Flow measurement devices shall be constructed to BS 7350, section 3.2 type 3, and shall be of the fixed orifice type either integral with or close coupled to a double regulation valve.

1.53.2 Valve construction shall be as specified for double regulation valves, with close-coupled fixed orifice fittings to BS 7350 table 6.

1.53.3 Valve ends shall be screwed to BS 21, or flanged to a suitable BS EN 1092-2 PN rating to match the pipework system.

1.54 Flow Measurement Devices – Sizes 65mm and above

1.54.1 Flow measurement devices shall be constructed to BS 7350, section 3.2 type 3, and shall be of the fixed orifice type either integral with or close coupled to a double regulation valve.

1.54.2 Valve construction shall be as specified for double regulation valves, with close-coupled fixed orifice fittings to BS 7350 table 6.

1.54.3 Valve ends shall be flanged to BS EN 1092-2 to a suitable PN rating to match the pipework system into which they are installed.

1.54.4 Where detailed elsewhere within this Specification or on the Contract Drawings, variable orifice valves shall be installed. They shall be constructed to BS 7350 section 3.2 type 4, and shall be constructed as detailed above.

1.54.5 All flow measurement devices shall be installed with the measuring points located in an upwards direction.

1.54.6 Individual flow measurement valves shall be installed within the pump discharge of each pump where pairs of pumps operate in parallel and incorporate automatic change-over operation.

1.55 Swing Check Valves – Sizes 15 to 50mm Inclusive

1.55.1 Swing check valves shall be installed within the pump discharge of each pump where pumps operate in parallel, and incorporate automatic change over operation.

1.55.2 All swing check valves shall be constructed to BS 5154, and shall be of the horizontal pattern type. Valve ends shall be screwed to BS 21

1.56 Swing Check Valves – Sizes 65mm and above

1.56.1 Swing check valves shall be installed within the pump discharge of each pump where pumps operate in parallel, and incorporate automatic change over operation.

1.56.2 All swing check valves shall be constructed to BS EN 12334, and shall be of the straight pattern, horizontal type. Valve faces shall be of copper or nickel alloy construction, and valve ends shall be flanged to a suitable BS EN 1092-2 PN rating to match the pipework installation.

1.57 Diversion Valves

1.57.1 Diversion valves shall be installed in all common feeds or vents.

1.57.2 For sizes 15 to 50 mm inclusive, screwed T-port valves with limit stops shall be used.

1.57.3 For sizes of 65mm and above, 3-way lubricated plug cock valves with limit stops shall be used, flanged BS EN 1092-2.

1.58 Relief valves – Sizes 15 to 50 mm inclusive

1.58.1 Relief valves shall discharge with opening action proportional to the increase in pressure above the set operating pressure.

1.59 Safety Valves

1.59.1 Safety valves shall discharge with rapid opening action to prevent the predetermined maximum pressure being exceeded.

1.59.2 All safety valves shall be constructed in accordance with BS 759, and shall be of the high lift type. They shall be stamped with the maximum safe operating pressure.

1.59.3 Springs shall be fitted in accordance with the system operating pressure, and all discharge outlets shall be piped to a suitable discharge point as detailed elsewhere in this Specification or on the Contract Drawings.

1.60 Radiator Valves

1.60.1 Radiator valves for two pipe non-reverse return systems shall be suitable for operation with a pressure drop across valves of less than 60kPA.

1.60.2 For two-pipe reverse return and one-pipe systems, wheel valves shall be used on flow pipework, and lockshield on return.

1.60.3 For two-pipe non-reverse return systems with a pressure drop across valves in excess of 60kPA, wheel valve on flow pipework and lockshield on return.

1.60.4 All radiator valves shall have tamper-proof set point limits and shall be installed in a horizontal pattern.

1.61 Automatic Control Valves

1.61.1 Automatic control valves shall be selected by the Control Specialist to suit his particular controls system. They shall be specifically designed to operate correctly to the requirements and dictation of the associated automatic control protocol.

1.61.2 The Contractor shall ensure that in all cases automatic control valves are selected to ensure that the pressure drop of the service flow through the valve in both full flow and bypass modes are arranged for the optimum control characteristics.

1.61.3 Pipework connected to automatic control valves shall be sized 'full bore' to carry the service flow, with pipeline reductions to the control valve.

1.61.4 The Contractor shall submit technical details of all small bore (20mm and under) control valves to his Water Treatment Specialist Company, to ensure that all chemicals used are compatible with the materials used in the construction of the valves.

1.62 Drain Cocks

1.62.1 Drain cocks shall be fitted to all low points in pipework systems, and adjacent to all main items of plant for maintenance purposes.

1.62.2 All drain cocks shall be equal to the main pipework line size, or a minimum of 25mm where the line size is greater than 25mm.

1.62.3 All drain cocks shall be constructed to BS 2879 type 1, and shall be of the bronze body type.

1.62.4 Valve ends shall be screwed to BS 21.

1.62.5 All drain cocks shall incorporate a screw-down plug with a square shank for loose lever. Serrated outlets of either fixed or union pattern shall be provided.

1.63 Gauge Cocks

1.63.1 Gauge cocks shall be provided for permanent pressure measuring points, as detailed elsewhere within this Specification or on the Contract Drawings.

1.63.2 All gauge cocks shall have renewable disc globe valves.

1.64 Binder Test Points

1.64.1 Binder test points shall be suitable for the system operating medium, pressure and temperatures. They shall be installed adjacent to the all the following items of plant and equipment, and shall be of the extended type to clear any insulation:

- Immersion temperature sensors.
- Inlets and outlets of heat exchangers, including all heater and cooler coils.
  Each port of all automatic control valves
- Inlet and discharge connections of all pumps.
- Inlet and outlet connections of all items of plant and equipment.
- All binder test points shall be of the self-sealing type, and shall be complete with captive caps for sealing when not in use.

1.65 Strainers

1.65.1 Strainers – Sizes 15 to 50mm inclusive

1.65.2 Strainers shall be constructed to BS EN 1982 and shall be of the bronze body type.

1.65.3 Body patterns shall be of the full bore Y type with internal to external flow through screen configuration.

1.65.4 Stainless steel mesh screen sizes shall not be less than 250% of pipe bores, and all perforations shall be within range of 0.7 to 0.9mm diameter.

1.65.5 Plugged connections screwed to BS 21 shall be provided for drain, air vent and pressure differential monitoring.

1.66 Strainers – Sizes 65mm and above

1.66.1 Strainers shall be of the cast iron body type.

1.66.2 Body patterns to be of the full bore Y type with internal to external flow through screen configuration.

1.66.3 Stainless steel mesh screen sizes shall not be less than 250% of pipe bores, and all perforations shall be within range of 1.5 to 1.8mm diameter.

1.66.4 All ends shall be flanged to BS EN 1092-2, of a PN rating to suit the local pipework installation.

1.66.5 Plugged connections screwed to BS 21 shall be provided for drain, air vents and pressure differential monitoring.

1.66.6 All strainers shall be complete with 25mm isolation valves and removable plugs for drainage and maintenance purposes.

1.67 Flushing Connections

1.67.1 Flushing connections shall be provided to comply with the BSRIA requirements.

1.67.2 All isolation valves installed for flushing purposes shall be identified, and retained as part of the final installation for maintenance purposes. Temporary pipework connections shall be removed on completion of flushing, prior to Practical Completion.

1.67.3 50mm plugged isolation valves shall be provided on all branches on the underside of the main pump suction headers (as high as possible), and on all return headers (as low as possible), for the purpose of initial flushing out and filling using temporary mains water connections.

1.68 Permanent Measurement Instrumentation

1.68.1 Gauges shall be installed in all locations as detailed elsewhere in this Specification and on the Contract Drawings.

1.68.2 All gauges shall be of the dial type and of robust construction, enclosed in dust-tight metal enclosures.

1.68.3 Dials shall incorporate white scales with clearly marked black lettering to indicate the measured values.

1.69 Pressure Gauge Connections

1.69.1 Pressure gauge connections complete with lever handle gauge cocks and interconnecting pipework and traps shall be installed on all items of major plant and equipment.

1.70 Pressure and Altitude Gauges

1.70.1 Vapour type pressure gauges shall be constructed to BS EN 387-1. They shall be connected to pipework systems via lever handle gauge cocks and cock connectors.

1.70.2 Dials shall be calibrated in either Pascals where differential pressures across plant or equipment are to be determined, or Bar where measuring head or working pressures. Dial graduation shall be from zero to between 1.5 and 2.5 times the normal operating working pressure.

1.70.3 Dial cases shall be 100mm diameter, heavy pattern, finished with chromium plating. Dial movement shall be clockwise rotation for increasing head.

1.70.4 Lever handle gauge cocks shall precede all connections to gauges. They shall be constructed of copper alloy body and lever, with screw inlet ends to facilitate connection and removal of gauges.

1.70.5 Gauges fitted on boilers and pressure vessels shall be clearly identified with operating and maximum permissible working pressures, in accordance with BS 759.

1.71 Temperature Gauges

1.71.1 Temperature gauges shall be constructed to BS EN 387-1, and shall be installed directly to the pipework systems via gland attachments on the thermometer stems.

1.71.2 All dials shall be calibrated in degrees Celsius on a logarithmic scale, from zero to approximately 150% of the actual working temperature. Pointer movement shall be clockwise for increase in temperature.

1.71.3 Dial cases shall be 100 mm diameter heavy pattern, finished in chromium plating.

1.72 Trace Heating

1.72.1 All exposed pipework liable to freezing shall be protected by means of self-regulating trace heating systems.

1.72.2 All systems shall be complete and fully functional and shall include all components including tapes, lockable and labelled isolators, thermostats, junction boxes and indicator lights necessary for its proper and satisfactory operation.

1.72.3 All trace heating systems shall be selected, designed and installed to achieve the required medium temperature, as detailed elsewhere in this Specification or on the Contract Drawings. Where no specific temperatures are given, the Contractor shall ensure that the temperature of the medium is not permitted to drop to within 5ºC of its freezing point.

1.72.4 All external air thermostats shall be arranged to inhibit the operation of trace heating at temperatures in excess of 10ºC above its design temperature.

1.72.5 All trace heating control boxes shall be provided with volt free contacts to allow for BMS monitoring of operation.

1.72.6 Indicator lamps shall be installed on the ends of each section of heating tape, and all insulation covering tape-protected systems shall have warning labels as detailed elsewhere in this Specification.

1.72.7 All trace heating shall be installed, tested and commissioned by a Specialist Company approved by the System Manufacturer.

1.73 Thermal Insulation

1.73.1 The Contractor shall supply and install thermal insulation as detailed elsewhere within this Specification and on the Contract Drawings.

No Kingspan affiliated products are to be used.

1.73.2 All insulation shall be carried out in a neat and effective manner. All insulation applied to any plant shall be neatly cut around all manufacturers' names and test plates to leave these visible.

1.73.3 All insulation shall be secured at centres as recommended by the insulation manufacturer, and to the approval of the Contract Administrator.

1.73.4 Where it is specified that pipework, ductwork, fittings or equipment shall be insulated, the Contractor shall ensure the setting out makes due allowance for the insulation.

1.73.5 Each pipe shall be insulated separately and adjacent parallel pipes shall not be married together with insulating material.

1.73.6 No insulation shall be applied until pipes, plant and ductwork have been tested and witnessed by the Contract Administrator. The Contractors attention is specifically drawn to the provisions for painting of pipework prior to the application of any thermal insulation. Prior to painting, all surfaces shall be thoroughly cleaned and, if necessary, wire-brushed and degreased.

1.73.7 All insulation shall be continuous through all builders work openings and pipework sleeves.

1.73.8 All insulation shall be manufactured and installed to ensure compliance with BS 3958, BS

1.73.9 5970 and BS 5422. All materials used shall be non-flammable to BS 476, and shall be subject to Building Control or Client approval. All finished surfaces shall be non-flammable to Class O.

1.74 Pipework Insulation

1.74.1 Internal Pipework (Concealed).

No Kingspan affiliated products are to be used.

1.74.2 Heating and chilled water pipes shall be insulated with reinforced aluminium foil faced 80/112Kg/m³ mineral wool rigid pre-formed sections. Longitudinal overlaps and butt joints shall be sealed with 50mm wide self-adhesive T303 aluminium foil tape.

1.74.3 Where the aluminium foil facing provides a vapour barrier, the Contractor shall ensure that all joints are adequately sealed with adhesive or tape, and that any damage to the facings is repaired with tape or sealant. All such repairs shall be subject to the approval of the Contract Administrator.

1.74.4 Chilled water pipework fittings requiring access, i.e. valves and strainers under 25mm, shall be insulated with oversized sections.

1.74.5 Heating valves in occupied spaces shall not be insulated. Heating Pipework in Plantrooms All heating pipework within plantrooms shall be insulated as detailed elsewhere in this Specification for occupied areas.

1.74.6 All insulation shall be finally covered with 0.8mm hammerclad sheet sections, secured at maximum 300mm centres with aluminium tensioning bands aligned both vertically and horizontally.

1.74.7 All bends and fittings shall be covered in matching sheet metal, tailored to fit.

1.74.8 Pipework insulation thickness shall follow CPI 2021.

1.74.9 Victaulic fittings where insulated shall have the same thickness of insulation as specified for the adjoining pipework.

1.75 Pipework Identification

1.75.1 Identification shall be applied to pipework at the following locations:

1.75.2 Adjacent to major plant, pumps, valve sets and major pipework and ductwork connections, e.g. headers, mixing circuits, etc.

1.75.3 Where services leave or enter a space, e.g. plantroom, builders work shaft, false ceiling void, etc.

1.75.4 In addition to the above, identification shall be placed every 5m along linear pipes and ducts external to plantrooms and 2m within plantrooms.

1.75.5 Non-insulated and insulated pipework shall be identified by permanent self-adhesive colour bands and code indications in compliance with BS 1710, BS 4800 or the flo-code system.

1.75.6 All colour bands shall completely encircle pipework with a minimum 25mm overlap, subject to a minimum length of 150mm. Each service shall be further identified by black lettering on a transparent self-adhesive tape, attached over the colour bands.

1.75.7 An arrow band shall be affixed on each colour band to denote the direction of flow.

1.75.8 A pipeline identification chart produced in white rigid plastic shall be provided and mounted in each plantroom. This chart shall provide a comprehensive key to all of the identification colours and codes employed on this project.

1.75.9 Cast iron drainage shall be unlabelled, painted black throughout where exposed, or provided with a black colour band where insulated.

1.75.10 Where trace heated, pipework systems shall have additional warning labels as detailed elsewhere in this Specification.

1.76 Gas Boilers – Multiple Installations

1.76.1 The Contractor shall supply, install and commission gas-condensing boilers within the boiler room, as shown on the Contract Drawings.

1.76.2 The boilers shall be modular, with ratings as detailed on the Contract Drawings or elsewhere in this Specification.

1.76.3 The boilers shall be installed in accordance with the manufacturer's instructions. The boilers shall be supplied complete with a module sequence controller.

1.76.4 An overriding high limit thermostat, which shall cause the boiler to fail safe in the event of failure of the actual boiler control thermostat, shall form part of the boiler controls.

1.76.5 Each boiler shall be fitted with an external connection facility for remote indication of failure (pilot extinguished and module lockout).

1.76.6 A safety valve complying with BS 759 should be fitted to each boiler. They shall be of the totally enclosed spring type, which has a seating of metal to a suitable resilient material. It shall not be mounted below the level of the top of the boiler. The safety valve shall be provided with a full-bore non-corrodible discharge pipe directed to the rear of the boiler to terminate vertically within 150mm of the floor with open end visible.

1.76.7 The safety valve setting should be 0.35Bar more than the maximum pressure on the system. Where no provision is made on the boilers it shall be fitted on the flow pipe, prior to any isolating valve.

1.76.8 A drain cock of not less than 25mm nominal size shall be mounted on the boilers where no provision is made it should be fitted to the lowest pipework point prior to any isolating valve.

1.76.9 Temperature indication shall be provided of the flow and return temperatures of each boiler.

1.76.10 The boilers shall be complete with casing.

1.76.11 The boilers shall be mounted on a 150mm concrete plinth which shall extend a minimum of 200mm beyond the boiler module casings all round.

1.76.12 The Contractor shall provide all necessary unions and flanges in order that the boiler modules may be individually removed for maintenance purposes.

1.76.13 The Contractor shall make adequate provision such that none of the connecting pipework is supported by the boiler pipework.

1.76.14 The Contractor shall ensure that adequate provision is made for combustion and ventilation air supply in accordance with BS 6644 and BS 5440 Part 2.

1.77 Chimneys and Flues

1.77.1 The Contractor shall supply and erect all necessary double skin, stainless steel, fully insulated chimneys for the gas boilers as detailed elsewhere in this Specification and shown on the Contract Drawings.

1.77.2 All flues shall be complete with appliance connectors, intermediate supports, fire stop spacers and support plates where passing through the roof, flashings and storm collars and terminals to the approval of the Contract Administrator. They shall incorporate all necessary twin-wall pipe, integrally insulated with 50mm thick Rockwool.

1.77.3 All twin walled flue where exposed to view shall be stainless steel internal and external. Where concealed from view the outer skin shall be 'Zalutite' steel. Where flues rise in builders work ducts an additional layer of foil faced 100mm thick Rockwool insulation shall be applied throughout its length to prevent heat gain into surrounding areas.

1.77.4 All flues shall be complete with draught stabilisers.

1.77.5 The height of the chimneys shall comply with the requirements of the relevant authorities. The Contractor shall allow for obtaining the approval of the Local Authority with regard to the provisions of the Clean Air Act. A drain point run permanently to a gully shall be provided from a purpose tee piece at the bottom of each flue.

1.77.6 Flue components and complete systems shall comply with BS 4543 Part 2, BS 6461 Part 2 and Part J of the Building Regulations.

1.77.7 Flues up to 203mm diameter shall be provided with a gas terminal. Flues 254mm diameter to 355mm diameter shall be provided with a round top terminal. Flues 400mm diameter and above shall be provided with a rain cap.

1.77.8 When flues extend more than 1.5m above the last integral support, then purpose designed rigid stays shall be provided.

1.77.9 The Contractor shall provide external exposed sections of the flue to be etched to an approved colour to be agreed with the Contract Administrator.

1.78 Pumps

1.78.1 The Contractor shall select, supply, install and commission the pumps as indicated on the drawings and shown in the schedule.

1.78.2 At suction and discharge pump connections, full-bore drain and sludge pockets shall be provided complete with a full-bore drain valve.

1.78.3 Duty and standby pumps, complete with non-return valves, shall be installed for all services except where detailed otherwise elsewhere in this Specification or on the Contract Drawings. Each pump shall be selected for 100% of the equipment duty as shown on the schedule of pumps.

1.78.4 All pumps shall be selected in mid duty range so that if an increase or decrease in duty of up to 20% of the design flow rate is required, a larger or smaller motor, pulley belt or impeller may be installed. Full pump characteristics shall be provided and these shall show the design characteristic and the maximum duty characteristic.

1.78.5 Starters and cables shall be selected to suit the maximum motor output and not the absorbed output.

1.78.6 All pumps shall be equipped with neoprene or stainless steel flexible connections suitable for the temperature and pressure ratings applicable. They shall have flanged connections with tappings for altitude gauges for both suction and discharge pressure measurement.

1.78.7 All pumps shall be installed with strainers situated on the suction side of the pump.

1.78.8 All pumps shall be constructed with cast iron casing and impeller, stainless steel shaft and long life mechanical seal. A blanking plate shall be provided for each different pump size.

1.78.9 Pump motors shall be silent in operation and the selections shall be based on a maximum speed of 1450rpm. They shall comply with the detailed requirements for motors as described elsewhere in this Specification.

1.78.10 Copies of factory test sheets shall be provided for all pumps provided under this Contract.

1.78.11 The Contractor shall be responsible for re-calculating the correct pump heads from the Installation Drawings for the approval of the Services Engineer.

1.78.12 The Contractor shall include for the correct pump and motor size to accord with these calculations.

1.79 Expansion Units

1.79.1 All expansion units shall comprise packaged systems containing a diaphragm type expansion vessel, break tank, run and standby pumps, pressure relief valve, pump control pressure switch, high and low pressure cut out switches, pressure gauge and all necessary isolating valves, etc. All individual devices shall be in compliance with the detailed requirements of this Specification.

1.79.2 Additional control equipment shall be included where applicable to comply with the "Health & Safety Executive" guides note PM5 hot water boilers category 'B', and where detailed elsewhere in this Specification or the Contract Drawings. This shall comprise electrode relays operated from electrodes positioned in the break tank to give the required alarm and cut-out facilities, the lowest level being lockout of the unit and equipment served.

1.79.3 The Contractor shall ensure that where applicable the pressurisation units supplied are compatible with the glycol solution of 30% in the chilled water circuit.

1.79.4 All units shall have volt free ‘Run’ and ‘Trip’ contacts to allow for BMS monitoring. Pressurisation units shall be finished to a colour (BS or RAL) to be selected by the Contract Administrator.

1.79.5 Where a pressure relief valve is not provided as part of the packaged pressurisation unit one shall be installed in the feed line from the unit.

1.79.6 Standard Feed and Expansion units shall be used on systems with a water content of 25,000 litres or less. Systems with a higher water content shall use a ‘spill press’ type unit.

1.79.7 Plate Heat Exchangers

1.79.8 The Contractor shall supply and install heat exchangers where indicated on the Contract Drawings, and to duties shown in the Schedules of Heat Exchangers elsewhere in this Specification.

1.79.9 Unless noted otherwise, all exchangers shall be plate type, constructed from stainless steel to AISI 304. All plates shall be retained in a purpose made steel frame, nozzles shall be nitrile lined and connections shall be flanged to BS EN 1092-2.

1.79.10 In accordance with Health and Safety requirements all exchangers shall be provided with thermally insulated side and top spray guards utilising 50mm thick Rockwool slab sections foil faced on both sides.

1.79.11 All plate heat exchangers shall be installed in accordance with the manufacturer’s recommendations.

1.80 Condensate Drainage

1.80.1 Unless specifically detailed otherwise, condensate drainage shall be arranged for gravity drainage.

1.80.2 Condensate pipework installations shall be carried out in MuPVC with solvent weld fittings to BS 5255. The minimum size of pipe used for condensate drainage shall be 20mm nominal bore. Although not subject to high pressure, condensate installations shall be pressure tested to 0.5bar, for a period of 30 minutes and show no signs of leakage.

1.80.3 Thermal insulation shall be applied to the first 1.5 metres of condensate pipework from the equipment drip tray. The thermal insulation shall be Armaflex Class 'O' insulation, 13mm thick, as manufactured by Armstrong Industries. All insulation joints shall be made using Armaflex adhesive.

1.80.4 Pipework on gravity drain systems shall be graded to fall continuously to the drain point at a minimum gradient of 1 in 300.

1.80.5 Direct connection into soil or rain water stacks shall not be permitted and an air break shall be provided using a trapped tundish connection into the stack using approved fittings.

1.81 Support System

1.81.1 The Contractor shall supply and install complete cable tray systems for supporting the refrigerant pipework and associated control wiring, over their entire lengths.

1.81.2 The cable tray shall be manufactured from mild steel to BS 1449, Part 1, with Admiralty type perforation pattern.

1.81.3 Standard cable tray thickness shall be not less than 1.0mm for widths up to 100mm, 1.5mm for widths between 100mm and 450mm and 2.0mm for widths over 457mm.

1.81.4 Standard cable trays shall be provided with single flanges of minimum height 13mm for widths up to 305mm and 19mm for 305mm widths and above.

1.81.5 Heavy duty cable tray thicknesses shall be not less than 1.5mm for widths up to 305mm and 2.0mm for widths between 305mm and 610mm. Heavy duty cable trays shall be provided with return flanges of minimum height 51mm with a 32 mm return.

1.81.6 Cable trays shall be galvanised to BS 729 except where it is installed within corrosive atmospheres where the tray and any associated components shall be PVC coated.

1.81.7 Accessories and manufacturer's bends and intersections shall be used and shall have an internal radius of 50mm for standard cable trays and 45º gussets for heavy duty cable trays. Accessories shall be of a similar construction and finish to the cable tray.

1.81.8 Cable trays shall be arranged in a neat manner and installed parallel with the building structure.

1.81.9 When sections of tray are cut, all sharp edges shall be removed and exposed metalwork painted with rust inhibiting paint. Holes through the tray shall be similarly treated and suitably bushed.

1.81.10 Cable trays shall be fixed to galvanised steel channel to provide a minimum clearance between structure and tray of 25mm for cable tray widths up to and including 225mm and 40mm for larger sizes.

1.81.11 Where cable trays are run horizontal, where possible, the cable side of the tray shall face upwards and shall provide a minimum clearance of 150mm between tray and structure or other services.

1.81.12 The tray shall be securely fixed at not less than 1000mm intervals and at 225mm from bends and intersections.

1.81.13 All joints in sections of cable tray and fixings of tray to support brackets shall be achieved by means of round or mushroom headed screws and nuts. The screws shall be installed with the head on the inside of the tray, clear of any cables and at least two screws per joint or fixing shall be used.

1.81.14 Cable tray shall be electrically continuous throughout, but shall not be used as the earth return path for the electrical installation.

1.82 Controls

1.82.1 Intelligent, addressable control systems which must maximise energy efficiency of the system as a whole and respond appropriately to inputs from refrigerant and air temperature sensors, refrigerant leak detection, fire detection and general alarm systems. Control components and equipment should be selected to meet these system control requirements and be from the equipment manufacturer's standard product range.

1.83 Control Field Wiring

1.83.1 The Contractor shall install, test and commission control wiring associated with the various plant.

1.83.2 Generally, the wiring installation shall be installed using galvanised trunking and conduit. Where appropriate medium duty galvanised perforated return flange cable tray shall be used.

1.83.3 The control wiring for the system shall be carried out strictly in accordance with manufacturers' recommendations using multi-core screened cables.

1.83.4 The controls specialist shall allow for all necessary wiring to provide a complete fully functioning system.

1.83.5 The Electrical Contractor shall provide, install and test the sub main cable to the air conditioning plant where there is an indicated 'direct mains supply'.

1.84 Water Treatment

1.84.1 General

1.84.2 The Contractor shall employ a Quality Assured water treatment specialist for the design, supply, analysis, installation and operation of all systems involved in the cleaning and chemical treatment processes.

1.84.3 The specialist shall design water treatment systems to control corrosion and bacteria growth in accordance with this Specification and the Contract Drawings. The Contractor shall notify all manufacturers and suppliers of plant and equipment connected to or otherwise effected by the water systems of the proposed cleaning and chemical treatment processes to be carried out. The Contractor shall obtain the written approval of all such manufactures and suppliers, and submit same to the Contract Administrator for his approval prior to the commencement of any water treatment works.

1.84.4 Where such equipment is supplied by others, the necessary confirmation will be obtained by the Contract Administrator when requested by the Contractor.

1.84.5 The Contractor shall ensure that all cleaning and chemical treatment complies with the Local, Statutory and Health & Safety Regulations.

1.84.6 The Contractor shall ensure the point of discharge for any chemicals used is into a foul drainage system, not a surface water system. The Contractor shall be responsible for advising and obtaining all approvals necessary from the Local Water Authority before any chemicals are disposed of via the drainage system.

1.84.7 If required by the Local Authority the Contractor shall provide effluent storage tanks for the storage of all waste products of the cleaning and chemical treatment processes. Subject to Local Authority approval, the effluent shall be neutralised and disposed of to the foul drainage system.

1.84.8 Where this is not possible, the Contractor shall ensure that all waste is stored, removed and disposed of by a suitably-licenced and authorised disposal specialist. Certificates recording details of the quantities and locations of all waste material removed from site shall form part of the Contractors' Health and Safety File.

1.84.9 The Contractor shall comply with the Waste Management Duty of Care: Code of Practice, and Control of Pollution Regulations 1980. The water treatment specialist shall ensure that all COSHH and Health and Safety Documentation is available on site for all chemicals used. The specialist shall dispose of all empty containers in accordance with statutory requirements.

1.84.10 The Contractor shall supply and install an eye wash station adjacent to every dosing point.

1.85 Flushing and Pre-Commissioning of Heating, Chilled Water and Condenser Systems

1.85.1 Prior to commencement of any chemical water treatment works, the Contractor shall undertake the following:

1.85.2 The complete system or section of system shall be covered by a certified and witnessed pressure test certificate.

1.85.3 Circulation shall have been demonstrated and approval obtained from the Contract Administrator on all parts of the systems.

1.85.4 All items of plant and equipment (including control valves) subject to damage or blockage due to the flushing, cleaning and chemical treatment processes, shall be isolated or removed.

1.85.5 With the exceptions of the sections of the systems isolated, all valves shall be left fully open.

1.85.6 All permanent or temporary bypasses shall be installed.

1.85.7 All drains and associated pumping equipment shall be tested, commissioned, certified and approved.

1.85.8 Confirmation shall be provided that all chemicals are compatible with the equipment used, as detailed elsewhere in this Specification.

1.85.9 All air vents shall tested and commissioned.

1.86 Flushing Processes

1.86.1 The Contractor shall ensure that the water treatment specialist is responsible for the entire flushing and chemical cleaning processes.

1.86.2 Flushing shall be strictly in accordance with the CIBSE commissioning code section W.1.1. and the BSRIA Application Guide 8/91.

1.86.3 All equipment (including temporary pumps) and associated installation works necessary to comply with the above requirements shall be provided and installed by the Contractor.

1.86.4 All strainer baskets and filter media shall be removed and thoroughly cleaned during and after flushing. Temporary strainers and filters shall be installed as required for the removal of solids during cleaning process.

1.86.5 The Contract Administrator shall witness the whole flushing process, and his approval shall be obtained before pre-commission cleaning commences.

1.86.6 An individual certificate of cleanliness, signed by the operatives responsible, shall be issued upon completion of each stage of the works.

1.87 Pre-Commission Cleaning Processes

1.87.1 The chemical cleaning procedures shall be carried out in accordance with the BSRIA Application Guide 8/91.

1.87.2 The Contract Administrator shall witness the chemical cleaning process.

1.87.3 Samples shall be taken before, during and upon completion of the chemical treatment and /or cleaning processes, and shall be submitted to an independent analyst. Sterile containers shall be used. All test and sample results for certification shall be submitted to the Contract Administrator for approval.

1.87.4 All hydraulic systems shall be left full on completion of the flushing and chemical cleaning. The systems shall have an initial dose of anti-corrosion inhibitor injected into the system, and mixed throughout to prevent any corrosion. A shock dose of biocide shall be added to prevent bacteriological growth/activity in the system. This injection shall immediately follow final flushing, and all chemicals used shall be subject to the approval of the Contract Administrator.

1.88 Water Treatment, Chemical Injection and Dosing Methods for Closed Open and Recirculating Systems

1.88.1 The Contractor shall be responsible for confirming the water system volumes from the installation drawings, and for their submission to the Contract Administrator.

1.88.2 The Contractor shall be deemed to have included in the tender for sufficient chemicals to accord with his calculations.

1.88.3 All water systems shall be provided with scale and corrosion control to the approval of the Contract Administrator.

1.88.4 In closed systems, chemicals shall be introduced via dosing pots installed within the pipework system, across the primary system circulating pumps.

1.88.5 The injection method shall be manual.

1.88.6 Chemicals shall be as BSRIA Application Guide AG 2/93 Appendix A Table A1.

1.88.7 Suitable anodic chemicals shall be dosed into the system to ensure that the steelwork is rendered passive. A copper corrosion inhibitor shall also be included in the chemical formulation. An aluminium inhibitor shall be maintained in any system where aluminium is present.

1.88.8 Chemicals to be used shall include an isothiazolone compound as a biocide. Dichlorophen and Poly Quats shall not be used.

1.89 COSHH/Health and Safety

1.89.1 The Contractor shall ensure that all water treatment chemicals used on site are contained in secure storage chests in compliance with the requirements of H&SE Guidance Note CS19.

1.89.2 These shall include the following: Labels to BS 5378/BS 5499.

1.89.3 Tanked base for containment of accidental spillage incorporating drain plug. High and low level ventilation.

1.89.4 Storage chests shall form part of the completed installation, and shall be retained on site for use by Maintenance Personnel. The Contractor shall ensure that all COSHH sheets are clearly visible within the plantrooms, and copies included in O & M manuals.

1.89.5 Copies of all COSHH and Health and Safety documentation shall be passed to the

1.89.6 Planning Supervisor in accordance with the CDM Regulations.

1.90 Testing Commissioning and Technical Advice

1.90.1 The Contractor's testing and commissioning specialist shall be responsible for the complete testing and commissioning of all systems, including supply of all chemicals for initial cleaning requirements and those for a complete 12 months operation, including all necessary attendance, reports and technical advice.

1.90.2 The Contractor shall assume normal five-day per week, ten hours per day operation, with an operational factor of 70%.

1.90.3 The Contractor shall issue to the Contract Administrator copies of a visiting fully qualified chemist's service report after each monthly site visit. They shall detail the medium hardness, inhibitor level, dissolved solid level, pH, and total alkalinity, clearly indicating the control limits. They shall check the performance of all injection and testing equipment on site and confirm their status. A full micro- biological analysis utilising dip slides shall form part of the monthly visit.

1.90.4 The water treatment specialist shall provide a complete training programme for site operatives, which shall cover as a minimum:

- Methods of water testing
- Explanation of results
- Action to be carried out on test results

1.91 Operating and Maintenance Manuals

1.91.1 Contractor shall provide within the O & M manuals the following: Product notes and material safety data sheets for all chemicals used. Equipment data and drawings.

1.91.2 All cleanliness certificates. Water treatment programmes. Purpose of each chemical.

1.91.3 Chemicals used and quantities of each. Site testing procedures.

1.91.4 Control limits of each individual test.

1.91.5 The water treatment specialist shall include for all system log books. Consideration shall be given in the O & M manuals to the problems of Legionnaires Disease and other related illnesses with particular reference to TM17 and HS(G) 70 documentation.

1.92 Incoming Gas Services and Site Distribution

1.92.1 The gas service riser shall be a 'pipe within pipe' construction with the outer sleeve having an internal diameter at least 25mm greater than the outside diameter of the gas pipe. Joints shall be staggered and the pipe shall be vented in the gas meter room and externally to BS 6891.

1.92.2 All Pipework and fittings shall be black carbon steel heavy grade, to BS 1387 for sizes of 15mm to 150mm, and to BS EN 10162 Grade 4301 for sizes 200mm and above. All pipework fittings to BS 1965 Part 1/BS EN 10253-1 for sizes 200mm and above.

1.92.3 All oxy-acetylene welding shall be carried out to BS 1821 or BS2640, subject to system temperature and pressure

1.92.4 All arc welding shall be carried out to BS 2633 or BS 2971 subject to system temperature and pressure. Arc welding process shall be carried out on pipework 100mm and above.

1.92.5 The testing procedure shall be in accordance with BGC 1M/5, and the purging procedure with BGC/1M/2.

1.92.6 Where shown on the Contract Drawings, the Contractor shall provide in the incoming gas service in the meter room with a gas solenoid valve. The valve shall be controlled by an electro-thermal link above each boiler, emergency 'knock off' switches situated outside the boiler room doors, and interconnections to the fire alarm and gas detection systems. This system shall be arranged to shut the gas valve and break the electrical supply to the boilers.

1.92.7 The system shall be provided with a 220 volt battery back up to provide a maintained power supply in the event of a power failure.

1.92.8 The gas valve shall have a status monitoring facility for connection to the BMS (where applicable). A manual gas shut off valve shall be positioned immediately inside the boiler room.

1.92.9 To accord with BGC requirements the Contractor shall provide a gas supply line diagram in addition to the normal record drawings which shall be fitted in the gas meter room.

1.93 Gas Detection

1.93.1 The Contractor shall provide a single channel gas detection control unit within a suitable enclosure outside the boiler room, which shall be to IP65 if external, complete with catalytic filament sensor(s).

1.93.2 The gas detection unit shall also shut the gas solenoid valve on an alarm signal.

1.93.3 The system shall have a status monitoring facility for connection to the BMS (where applicable).

1.93.4 All detector wiring shall be MICC/LSF with orange sheath and 105^{O}C earth-tail glands, pots and seals. It shall be installed on cable tray, as described elsewhere in this Specification.

1.94 Mechanical Services Control Panels

1.94.1 Compartmentalised Motor Control Centres (MCC) Compartmentalised mechanical services motor control centres, hereinafter defined as MCCs, shall comply with the following Specification. MCCs shall be floor standing, and of sheet steel construction.

1.94.2 Each group of associated plant motor starting equipment shall be housed within a sheet steel enclosed cubicle or cell within the enclosure of the MCC. Each MCC cubicle shall have an independent hinged lockable door with interlocked lockable isolator, together with associated control switches.

1.94.3 The grouping of plant controls within MCC cubicles shall be as identified elsewhere in this Specification or on the Contract Drawings.

1.94.4 Generally, duty and standby plant shall be located in different cubicles.

1.94.5 The MCC extra low voltage common controls and building/energy management system hardware shall be located within their own cubicle, forming a complete vertical section of the enclosure. The common controls cubicle shall have an overall door with clear Perspex vision screen of full height revealing the status indication and control switches within. The common controls cubicle shall have an inner full height cantilevered swing frame door that shall form a base for common control status indication and control switches.

1.94.6 MCC panels shall comply with Form 4 Type 7, as defined in BS EN 60 439 - 1 IEC 439-1

1.95 Wardrobe Type Mechanical Services Control Panels - Purpose Constructed (WTMP)

1.95.1 Wardrobe type mechanical services control panels' purpose constructed, hereinafter defined as WTM-P, shall comply with the following Specification.

1.95.2 WTM-P shall be floor or wall mounted as detailed on the Contract Drawings, and shall be of sheet steel construction.

1.95.3 WTM-Ps shall have all motor starters and power distribution systems housed behind common vertical hinged access doors. Each vertical section shall have internal vertical steel segregation partitions with door interlocked lockable isolators. Plant control equipment shall be arranged in logical groups, to the approval of the Contract Administrator.

1.95.4 WTM-Ps shall have extra low voltage common controls and building/energy management system hardware located in a vertical section forming a separate cubicle of the enclosure. The common controls cubicle shall have an overall door with clear Perspex vision screen of full height revealing the status indication and control switches within. The common controls cubicle shall have an inner full height cantilevered swing frame door that shall form a base for common control status indication and control switches.

1.96 Wardrobe Type Mechanical Services Control Panel - Manufacturers Standard Construction (WTM-S)

1.96.1 Wardrobe type mechanical services control panels of manufacturers' standard construction, hereinafter defined as WTM-S, shall comply with the following Specification.

1.96.2 Standard construction control panels shall only be provided for off-site manufactured package equipment. All other control panels shall be purpose-constructed, as defined for WTM-P.

1.96.3 WTM-S enclosures shall be finished in manufacturer's standard finish, with standard indicators and controls. WTM-S shall be generally pre-wired and fixed to their associated packaged equipment, or where appropriate wall/floor fixed adjacent the equipment.

1.96.4 WTM-S shall in particular be suitable for operation and installation in the UK. In this regard any standard control equipment manufactured overseas shall be modified at source to comply with British Standards, the Latest Edition of the IEE Wiring Regulations and English Law (the Electricity at Work Act, the Health and Safety at Work Act, etc.).

1.96.5 WTM-S shall have door interlocked lockable isolators and hinged doors. In every other respect, unless advised to the Contract Administrator by the Contractor within his tender return, it shall be assumed that WTM-S meet the full requirements of MTM-P.

1.96.6 This Specification shall be read in conjunction with the Contract Drawings and Schedules.

1.97 General Constructional Requirements for MCC, WTM-P and WTM-S Control Panels

1.97.1 Enclosures

1.97.2 All panels shall comply with the requirements for type tested assemblies under IEC 439- 1 and EN 60 439-1.

1.97.3 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, they shall be constructed for front and side maintenance access only, and for all cable access from above.

1.97.4 All components and internal connections within the enclosure shall be suitable for a short circuit fault level of 25kA for 1 second, or any other fault level specified, appearing on the incoming terminals. All bus bars shall be ASTA certified (or EOTC equivalent).

1.97.5 All equipment used shall comply with BS EN 60 947-1.

1.97.6 Enclosures shall be free-standing, manufactured and constructed to a rigid form from not less than 2.0mm "zintec" or equal sheet steel frame with 1.6mm for internal partitioning. The equipment shall be in cubicle form with bus bars as specified, and shall be suitably braced and stiffened for the required duty.

1.97.7 Individual enclosure fabricated sections shall not exceed 2.3m in height, width 2.4m and depth 0.5m. Adjacent sections shall be jig-drilled to ensure accurate site assembly. The Contractor shall ensure actual dimensions site switches, distribution boards etc. shall be located between 0.4 and 1.8 metres from the finished floor level.

1.97.8 The enclosure shall be designed so that further sections may be added at either end to form a continuous mechanical and electrical extension, via bolt-fixed gland plates.

1.97.9 Removable type lifting eyes shall be provided at suitably strengthened locations on the top of each enclosure section. When the lifting eyes are removed the stud holes shall be suitably capped.

1.97.10 For internal locations enclosures shall be designed and constructed to be damp, dust and vermin protected to IP44 (as defined in EIC 529/DIN 40050). Externally mounted enclosures shall be weather protected to IP55 and shall be provided with a protective canopy mounted above and extending in front of the panel.

1.97.11 All drainage and ventilation holes shall be vermin proof.

1.97.12 All abutting components shall be provided with gaskets, metal to metal joints shall be avoided and all external bolts or screws shall be of plated brass and provided with gasket washers to prevent the ingress of moisture. Doors and access covers shall be rigidly constructed to avoid deflection or bending and provided with sufficient fixings to ensure an effective seal when closed.

1.97.13 Sections housing heat emitting equipment or electronic controls shall be ventilated mechanically by extraction fans, complete with integral thermostat.

1.97.14 Internal chassis mounting plates 2.5mm thick shall be provided. Plates less than 600mm high shall have one vertical edge returned, while larger plates shall as a minimum have all edges returned to stiffen the plate. One mounting plate shall be provided per door.

1.97.15 Door construction shall be folded in the form of rigid tray, stiffened internally if required, with a maximum width 900mm.Recessed sealing gaskets shall be fitted to give dust protective joints at all edges. Lift-off type hinges shall be provided to enable the removal of the door panel if required, and doors shall be arranged such that they can open to an angle of not less than 120^{O}. All doors shall be provided with locking-type door handles, using one common key for all locks on any given project.

1.97.16 A document pocket, adequately sized to suit the panel drawings, shall be provided and permanently fixed inside the panel.

1.97.17 Steelwork may be a proprietary system or specially fabricated, as detailed elsewhere in this Specification or on the Contract Drawings. Approval of the selected method and any subsequent changes from the chosen method shall be at the discretion of the Contract Administrator.

1.97.18 Sections housing equipment which remain "live" at voltages exceeding Extra-Low Voltage when the panel door is open, (busbar chambers etc.), shall carry adequate yellow warning labels with black engraving as detailed elsewhere in this Specification. They shall include shrouding to prevent direct contact with live equipment.

1.97.19 All access doors and covers shall be sealed with an expanded neoprene gasket that shall be fitted (not glued) to the inside perimeter face.

1.97.20 Removable cable gland plates and conduit entries shall be provided to accommodate the incoming and outgoing cabling.

1.97.21 Enclosures shall include internal fluorescent lighting within each section, controlled via automatic Extra Low Voltage door switches. Control sections which house equipment designed for temporary connection to portable data loggers, laptop computers, etc. shall incorporate a 13A switched socket outlet for this purpose.

1.97.22 External surfaces, edges and corners shall be smooth to avoid the collection of dust and to facilitate cleaning.

1.97.23 Unless detailed otherwise elsewhere in this Specification or on the Contract Drawings, all enclosures shall have finishes as follows:

1.97.24 Internals of Enclosure: Applied to the rust inhibited sheet steel shall be zinc phosphate paint with undercoat and finishing coat of matt white.

1.97.25 Externals of Enclosure: Shall be to manufacturer's standard colour.

1.97.26 On weatherproof IP55 enclosures the inside finish shall be as above, while the external finish shall be as above but with an additional coat of epoxy resin paint drying to a high gloss finish.

1.97.27 Unless otherwise specified enclosures shall be floor standing mounted on purpose cast concrete plinths of height 100mm above screeded floor level. The enclosures shall have a further integral 100mm galvanised H- section steel plinth. A layer of bitumous felt shall be placed between panel base and concrete plinth.

1.98 Incoming Section

1.98.1 Panel incomers shall consist of a door-interlocked isolator, mounted within dedicated cubicles for MCCs and within the power section for WTM-S/P. The panel fascia shall be fitted with the isolator operating handle, together with an ammeter and voltmeter and their associated selector switches where noted elsewhere in this Specification or on the Contract Drawings.

1.98.2 The isolator shall comply with BS EN 60 947-3 and shall be of the fault making, load breaking type. It shall be interlocked such that the cubicle door cannot be opened with the isolator made. "On/Off" indication shall be provided, together with a means of padlocking the handle in either the on or off position.

1.98.3 Where fitted, MCB-protected control circuits and cooling fan supplies shall be derived from the secondary side of the isolator.

1.99 Controls Section

1.99.1 Controls sections shall be electrically and mechanically segregated from the power section of the panel. They shall house the control equipment as detailed elsewhere in this Specification.

1.99.2 An internally mounted multi-pole isolator shall be provided as detailed above, to disconnect the power both to the control circuits and 240V services within the section. Software/hardware driven electronic controls requiring maintained electrical supplies for retention of memory shall be derived from the primary side of the incoming isolator, and the section fascia shall be fitted with a warning label.

1.99.3 The control circuit shall operate at 24v AC, derived from an MCB within the power section, as detailed elsewhere in this Specification. An earthed-screen transformer shall be provided, with a double-pole MCB protected secondary.

1.99.4 "Control Circuit Live", "Control Circuit Failed" and "Fire Alarm Activated" lights shall be mounted behind the controls section vision door, together with a mushroom head, key- reset emergency stop button.

1.99.5 All control relays shall be DIN-rail mounting, and spaced to allow sufficient air circulation. They shall be of the plug-in type, with 24v AC coils. All timing devices shall be of the solid state programmable logic controller type.

1.99.6 Incoming and outgoing control wiring terminals shall be provided along the top of the controls section. No voltage in excess of 24v AC shall appear on this terminal rail. Terminals shall be DIN-rail mounted to BS EN 60 947-7-1, and shall be complete with all necessary clamps, dividers, etc. They shall be numbered to coincide with the control circuit wiring numbers, and space for a minimum of 20% spare terminals shall be provided.

1.99.7 Internal panel wiring shall be as detailed elsewhere in this Specification. It shall be contained within back-plate mounted slotted PVC trunking, with a minimum of 25% space for future expansion. A run of slotted trunking shall be provided above the incoming/outgoing control terminals, through which all external ELV wiring shall be neatly marshalled.

1.100 Earthing

1.100.1 All panels shall be fitted with earth bars, which shall extend the full length of both the controls and power cable glanding areas. The bars shall be of continuous un-jointed copper, not less than 25 x 6mm in section. They shall be supported to suit the prospective fault current detailed elsewhere in this Specification or on the Contract Drawings.

1.100.2 The earth bar shall be drilled to accept the circuit protective conductors of all incoming and outgoing cables. The incoming earth, the controls section, the outgoing trunking/traywork and the panel frame shall also be bonded to this bar.

1.100.3 Flexible bonding leads shall be provided such that all doors are securely bonded to earth. Individual bonding conductors shall also be provided to all equipment within the panel that is not specifically earthed, such as back plates, plinth, etc. All such cross bonding cables shall be not less than 4mm² copper with green and yellow sheath. Butt joints will not be accepted in lieu of this requirement.

1.101 AC Motor Controls

1.101.1 General

1.101.2 AC motor starters shall be provided for all motive equipment operating from an alternating current source. Methods of starting shall be as defined below, unless otherwise indicated elsewhere in this Specification or on the Tender Drawings:

Motors up to and including 5kW	- Direct on line.
Motors over 5kW, up to and drive including 37kW	- Start Delta or variable speed
Motors over 37kW, up to and 90kW or variable speed drive	- Auto Transformer electronic motor starter including

1.101.3 AC motor controls shall be modular in construction. All contactors and starters shall comply with BS EN 60 947-4-1. Motor starting contactors shall comply with BS 5424 Part 1 and BS EN 60156. They shall be uninterrupted rating and of mechanical duty Class III and Category AC3.

1.101.4 Each contactor shall be of the modular type with replaceable contacts and operating coil. It shall be possible to add further auxiliary contact blocks.

1.101.5 Contactor units shall have switch disconnector characteristics as defined in DIN VDE 0113. They shall be 'padlockable' in the off position and shall have short circuit switching capacities suitable for the fault level present, as detailed elsewhere in this Specification or on the Contract Drawings.

1.101.6 In all cases, the Contractor shall supply to the Contract Administrator sets of calculations to demonstrate the effectiveness of protection of control gear, cabling and motor for each drive in accordance with type 1 co-ordination as defined in IEC947-4-1. The calculations shall form part of the drawing package issued for comment/approval, and no manufacturing or purchasing of equipment shall commence until they have been revised to incorporate the Contract Administrator's comments.

1.101.7 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, trip conditions shall be connected to their respective red "trip" indicator lamps, with green "run" indication from contactor auxiliaries. All control wiring shall be at 24v AC, and shall be kept segregated from mains voltage cables.

1.101.8 The total wave-form distortion produced in the power supply in its worst case condition shall remain within the limits set down in Electricity Council Document G5/3.

1.101.9 When two motors are operating in sequence as automatic standby to each other, a selector switch shall be fitted to manually select the leading motor.

1.101.10 Where star-delta starting is employed, a control interlock circuit shall be provided via auxiliary contacts within the local isolator, such that it is not possible to start the motor by closing the isolator in the delta phase.

1.101.11 Unless noted otherwise elsewhere in this Specification of on the Contract Drawings, all starters shall incorporate the ancillary components scheduled below:

- "On/Off", "Test/Off/Auto" or "Stop/Start" push buttons (as dictated by circuit configuration).
- Auxiliary poles for sequence interlocking. Motor ammeter for drives above 5 kW.
- Thermistor protection relay for all drives of 30kW and above.

1.102 DOL and Star-Delta, up to 15kW

1.102.1 For motor ratings up to 15kW, fuseless modular contactor/combined over-current/short circuit protection unit assemblies shall be employed. They shall be DIN-rail mounting, and shall be provided with all necessary auxiliary equipment to achieve the control and indication functions as set out elsewhere in this Specification or on the Contract Drawings.

Trip units shall incorporate (as a minimum) the following user-configurable parameters: Ambient temperature compensation -5°C to +40°C

Short circuit trip threshold 8.5 to 14 x In

Over current trip threshold 0.6 to 1 x In

1.102.2 A manual trip-test facility shall also be provided. The trip units shall have single phasing sensitivity, with characteristics as defined in ICE 292.

1.103 Star Delta, Over 15kW

1.103.1 For ratings over 15kW without electronic or auto-transformer soft starting, traditional starter arrangements shall be employed, containing the following components:

1.103.2 Fused switch with suitably rated HBC BS 88 fuses.

1.103.3 Motor line contactors, with change-over timer and both electrical and mechanical interlocks where used for star-delta control.

1.103.4 Overload, providing both single phasing and overcurrent protection.

1.104 Auto Transformer Starters

1.104.1 Auto transformer closed transition star delta starters shall include the following: Ventilated compartment to house transition resistors, sized for 4 No starts/hour.

1.104.2 Manual reset high temperature sensor, arranged to operate the motor tip circuit and a local indicator lamp.

1.104.3 Transition contactor.

1.104.4 Adjustable timer to control the transition time.

1.105 Electronic Motor Starters and Variable Speed Drives

1.105.1 Electronic motor starters and variable speed drives shall be of the "soft start" type with energy saving features for part-loaded motors.

1.105.2 Starting: The starter unit shall gradually increase the applied voltage to the motor at a pre-set rate. A pre-set current limit shall be provided which, if exceeded, shall halt the voltage ramp until motor current reduces. The system shall incorporate a facility such that if after a further pre-set time the current has not reduced to the anticipated value, full voltage is applied to safeguard against the motor stalling.

1.105.3 Stopping: Either conventional stopping or a "soft" stop by a reducing voltage ramp shall be user selectable.

1.105.4 Power Failure: Power interruptions where the motor is significantly slowed shall re- initiate the start-up voltage ramp. Restart after power failures shall be automatic as soon as a start signal is received from the control circuit.

1.105.5 Energy Saving: Subsequent to starting the starter shall reduce the applied voltage to keep losses of part loaded motors at a minimum, and as a result at optimum power factor. Sudden increase in motor current shall cancel this feature as a safeguard against motor stall.

1.105.6 Protection: Thermal overloads and motor winding temperature trip devices shall be incorporated, as detailed elsewhere in this Specification. Internal circuit protection shall be provided to protect the power devices and control circuit. Loss of any phase or voltage outside internal tolerances shall automatically switch off the drive without damage to the hardware.

1.105.7 Fault Indication: Each starter unit shall incorporate a common alarm for remote connection, in addition to local indication for motor trip and over temperature, start over temperature and device failure.

1.106 Operation

1.106.1 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, motor starters shall operate as follows:

- Control Switch "Off" - the machine shall not run except under fireman's switch control. (Warning notices shall be fitted to switches controlling fire-fighting equipment).
- Control Switch "Test" - the machine shall run irrespective of external signals except for local lock stop buttons, plant protection safety interlocks and fireman's control.

1.106.2 Bus-Bars

1.106.3 Unless noted otherwise elsewhere in this Specification or on the Contract Drawings, all bus-bar systems within mechanical services control panels shall meet the following requirements.

1.106.4 Bus-bars shall be continuous throughout the panel and shall be located within an enclosed bus-bar chamber.

1.106.5 Bus-bars and bus-bar connections shall be high conductivity copper to BS 159 and shall be extensible at both ends. Bus-bars shall be of constant cross section, and straight as possible. Neutral bus-bars shall not be of reduced cross section.

1.106.6 Holes in the bus-bars shall have a diameter not greater than one third of the bus-bar width, and shall give minimum clearance to the fixing bolt. The resistance of any length of bus-bar containing a joint shall not be greater than that of an equal length of similar without a joint.

1.106.7 All joints and connections to the bus-bars shall be tinned.

1.106.8 All bus-bars with the exception to the earthing bar shall be insulated, and shall be clearly marked with the appropriate phase and neutral colours which shall be red, yellow, blue and black respectively. In accordance with BS 159 insulation shall be heat shrink or other approved method and of a form not affected by through faults.

1.106.9 Insulators shall be of approved design and shall be attached such that over-stressing the insulation when tightening connections shall not be possible.

1.106.10 The bus-bars and supports shall be arranged to withstand the effects of any fault current up to and including the maximum possible at the point of supply.

1.106.11 Connections to bus-bars shall be made in solid copper conductors with colour coded PVC extruded sheath "polyshrink" or equal and approved. The connections shall be terminated by means of soldered cable lugs.

1.106.12 Access to bus-bars and bus-bars connections shall be gained only by the removal of bolted covers. The covers shall be marked with traffolyte labels, as detailed elsewhere in this Specification. They shall be engraved black on yellow 25mm characters "BUS-BARS DANGER 415 VOLTS" and give the following particulars:

1.106.13 Short time rating (seconds) Fault withstand at 415 volts Phase to phase voltage present Current rating

1.107 Internal Wiring

1.107.1 All wires and cables within mechanical services control panels shall be selected to operate within the manufacturers published ratings under normal panel operation. Control wiring shall be in flexible cable to comply with BS 6231 type B.

1.107.2 All cables shall have sleeve type circuit identification ferrules at each termination. All internal wiring shall be colour codes as follows:

Phase L1	Brown Phase L2	Black Phase L3
	Grey Earthed Neutral	Blue
	Earth Connections other than Neutral	Green and Yellow

1.107.3 All control wiring within panels shall be served from the L2 phase, shall be of 1mm² minimum size and shall have insulation colours as follows:

240 volts	Brown for phase and Blue for Neutral
24 volts	Violet

1.107.4 Earthed neutrals for 24 volts shall be indicated by a green/yellow ferrule at each cable termination.

1.107.5 All wiring between the motor starters, relays and outgoing terminal block compartments shall be installed within wiring channels complete with cable retaining clips.

1.107.6 Panels shall incorporate terminal blocks, barriers to segregate incoming, outgoing and extra low voltage wiring sections, and cable trays with cleating facilities or slotted PVC trunking for incoming and outgoing cables.

1.107.7 Adequate space shall be provided within termination areas to allow the cables to bend and spread from cable gland plates to the terminals in a simple and logical parallel formation, without crossing of cores. It shall be possible to remove any cable from the chamber without disturbing adjacent cables.

1.107.8 Separate vertical and horizontal wiring routes shall be provided for the extra low voltage controls wiring. These may comprise electro-magnetically screened sections within the mains voltage wiring ways.

1.107.9 Where wiring passes through holes in metalwork, suitable grommets shall be used. In no case shall cables be unprotected where they come in contact with the edges of metalwork.

1.107.10 Control circuits cables may be bunched into looms not exceeding 30 conductors in each, or contained within slotted PVC trunking when the cables shall not occupy more than 40% to the cross section.

1.107.11 Wiring to de-mountable door sections shall have multi-strand flexible copper conductors, and shall be contained within plastic spiral cable wrapping. Cable looms shall be of sufficient length to ensure that door sections can be fully opened without snagging, rubbing or chafing of the loom. Looms shall be securely located at each end using bolt or stud fixing clamps.

1.107.12 Each circuit of cables in wiring channels shall be strapped at maximum intervals of

1.107.13 600mm with nylon cable strap. All circuits in wiring channels following the same route shall be loomed together with nylon cable straps at maximum intervals of 300mm, with additional strapping at bends.

1.108 Outgoing Supplies

1.108.1 Each motor rated at 0.37 kW or larger shall be supplied from a dedicated starter.

1.108.2 Items of packaged equipment supplied complete with integral starters, fuses, etc. requiring a supply greater than 20A, single or three phase, shall be fed from a fuse switch of suitable rating mounted within the power section of the panel.

1.108.3 When packaged equipment requires a supply fuse rating of less than 20A it may be supplied from the panels integral distribution board. Each distribution board shall be supplied from a fuse switch in a separate cubicle, generally as detailed above.

1.109 Distribution Boards

1.109.1 Unless detailed otherwise elsewhere in this Specification or on the Contract Drawings, internal panel distribution boards shall be of the Miniature Circuit Breaker type in compliance with BS 5486-12.

1.109.2 Distribution boards shall form an integral part of the panel, and shall be enclosed in a separate cubicle complete with a hinged lockable cover.

1.109.3 Control MCBs shall be fitted within the appropriate starter cubicles, and shall not be derived from distribution boards.

1.109.4 MCBs shall be single or triple-pole as appropriate to the load supported. They shall be suitable for operation at the fault level present at that point in the system subject to a minimum of 9kA, and shall be of an operational type suitable for the duty of the equipment served. All MCB's shall comply with BS EN 60898, 'Miniature air-break circuit breakers for AC Circuits', and IEC 898.

1.109.5 Circuit breakers supporting socket outlet circuits shall be combined MCB/RCD units with 30mA-rated trip coils, in compliance with BS 4239.

1.109.6 All circuit breakers shall be permanently labelled with their type and current rating. All outgoing ways shall be numbered, and in all cases the phases shall be indicated by the appropriate colour.

1.109.7 The neutral bar of each distribution board shall be fitted with one clamping screw type connection for each outgoing circuit. Where TP & N boards are used to feed single-phase circuits, three such connections shall be provided for each outgoing way.

1.109.8 A minimum number of ten per cent spare three phase ways (subject to a minimum of 2 No) shall be provided in each distribution board.

1.109.9 A suitable retaining frame comprising a 3mm thick clear Perspex pocket shall be provided on the rear of the cubicle door, containing circuit charts. Circuit charts shall indicate cable, CPC and MCB types and sizes/ratings, as detailed elsewhere in this Specification.

1.110 Terminations

1.110.1 Terminal locations shall conform to the panel layouts, and each terminal shall be uniquely marked to an agreed scheme.

1.110.2 Extra low voltage terminals shall be separated from other terminals by location in separate areas or by rigid isolating barriers.

1.110.3 All terminals shall be of the rail-mounted type, and a minimum of 10% spare capacity shall be provided on each rail.

1.110.4 Control and power wiring terminal blocks for cables up to 16mm² shall be of the clamp type with wire identification labels. Power cabling terminal blocks for cables greater than 16mm shall be of the stud type transparent covers.

1.110.5 No more than two cables shall be terminated on any one terminal. All outgoing terminals shall be capable of accepting two 2.5mm² PVC insulated cables minimum.

1.110.6 Where panels are split for transport wiring between sections shall use plugs and sockets to facilitate site erection.

1.110.7 All internal panel terminations shall be made using lugs, pin or bootlace crimped ferrules with each terminating wire identified.

1.110.8 All cable entries in control panels shall comprise cable boxes and/or gland plates. Entries shall be provided and drilled to accommodate the cables as indicated on the schematic drawings and cable schedules. For single core power cables non-ferrous gland plates shall be provided.

1.110.9 Spreader bars and supports shall be provided when large or parallel multiple cables are to be terminated.

1.110.10 Where the cable length between gland and termination is in excess of 600mm provision shall be made for intermediate support.

1.111 Control Switches

1.111.1 Starter selector switches shall be of the 2 or 3 position modular type with up to 3 switch blocks in 2 banks. Each switch shall be normally open or closed as required for the function. Push buttons shall be of the same design but with push instead of rotary stay- put actuators.

1.111.2 Duty selection and other switches requiring more than 3 positions shall be of the rotary cam type, rated for at least 10A at 240V.

1.111.3 All selector switches shall be readily accessible, adequately protected and arranged to prevent the collection of dust and moisture film between contacts.

1.111.4 Duty selector switches for motors operating in sequence or as automatic standby to each other shall be mounted with their associated equipment and shall be fully shrouded to prevent accidental contact.

1.112 Relays

1.112.1 Relays shall be rail mounted with 0.5 times the relay width between them. Relay terminals shall be recessed to afford maximum electrical safety. Relays or groups with identical function shall be provided with at least one spare changeover contact. Plug-in relay types shall be selected with differing pin arrangements for each coil voltage used.

1.112.2 Cyclic timers shall be electronic with relay outputs, and adjustable for on and off periods separately. Mounting and connections shall be detailed above. Interval timers for periods of less than 5 minutes shall be electronic with switched replay outputs. For longer intervals synchronous motor driven clutch timers shall be used.

1.112.3 Pneumatic bellows timers shall only be used for sequence timing within reduced voltage starters.

1.113 Timeswitches

1.113.1 Clock time switching devices shall be of the programmable electronic type with memory supported by a re-chargeable battery to retain the selected switching times and the real- time clock for a minimum period of 72 hours in the event of loss of power.

1.113.2 Each unit shall be adjustable to perform up to 3 switching cycles on any one channel in any one day for each day of a weekly cycle.

1.114 Power Switches

1.114.1 Power switches shall comply with BS EN 60947-3 and shall be of quick make, quick break type with operating mechanism door interlocked to prevent access to the equipment unless the switch is in open position. It shall also be impossible to close the switch whilst the cubicle door is open unless an interlock is purposely defeated.

1.115 Motor Overloads

1.115.1 Motors shall be protected by circuit breakers and thermal-type overload devices, as detailed elsewhere in this Specification. Motors of 30 kW and above shall be provided with thermistor protection. Thermistor protected motors shall be supplied with a sensing device in each winding and a compatible control unit fitted within the associated motor starter cubicle or panel section.

1.115.2 Thermistor motor protection units shall be of the hand reset type and not resettable except by manual means regardless of the state of the electrical supply. Operation of the sensing device shall cause an indicator light to be illuminated on the panel fascia.

1.115.3 All motor thermal overloads shall be of the manual reset type with adjustable tripping current values. Where tripping currents are beyond the range of overloads, they shall be indirectly driven by current transformers.

1.115.4 All three phase thermal overload relays shall be of the differential type such that failure of any phase shall cause the relay to trip the motor contactor below the overload current setting. Overload relays shall be fully ambient temperature compensated to 50°C. Overloads in star delta starters shall be in circuit during run up.

1.116 Indicators

1.116.1 All fascia-mounted indicator lights shall be 24 volt circuit units of a common pattern incorporating 28 volt lamps and of cap type not interchangeable with 6 volt types. They shall be circular with heavily chromed surrounds and shatterproof plastic lenses.

1.116.2 Pilot light lens colours shall generally comply with BS EN 60073, with green indicating run and red indicating a fault condition.

1.116.3 Voltmeters and Ammeters shall be on the moving coil type and shall comply with BS 89/BS EN 60051. Voltmeters shall have a full scale deflection of 500 volts. Ammeters shall be scaled to normal run condition with adjustable red line indication and condensed over scale marking for start conditions. Current transformers shall be used for any load greater than 15A.

1.116.4 The VA rating and accuracy of current transformers shall be related to the type and magnitude of the load. They shall have over-current characteristics suitable for the prospective short circuit of the system and shall comply with BS EN 60044-1/ IEC 60051-2.

1.116.5 Voltmeters shall be supplied with a protective fuse. Current transformers shall have their secondary windings connected to the panel earth via a link.

1.117 Labels

1.117.1 All labels shall be in compliance with the detailed requirements of this Specification.

1.117.2 Name plates and labels shall be provided on all motor control centres, cubicle doors, voltmeters, ammeters, control fuses, relays, terminals etc.

1.117.3 Details of all labels to be agreed with the Contract Administrator.

1.117.4 External labels shall be engraved 3-part laminate with black lettering on white background. "Danger 415V" labels where required shall have black lettering on yellow background.

1.117.5 All labels shall be fixed with brass screws tapped into the equipment covers.

1.117.6 Unless otherwise stated lettering shall be 5mm minimum height with larger for overall function descriptions and cubicle designation descriptions. The labels shall be arranged to surround groups of associated equipment (e.g. switch and associated pilot lights).

1.117.7 Labels for internal equipment shall be fixed to the back plates adjacent to the item referred to, not the item itself or an adjacent removable item such as trunking lid.

1.117.8 All control panels shall be fitted with an engraved label stating details of the Consultant

1.117.9 Engineer, minimum of 60 No 6mm high characters, exact wording to be agreed.

1.118 Sensors (Room and Duct)

1.118.1 Unless detailed otherwise elsewhere in this Specification or on the Contract Drawings, temperature sensors shall be generally of the PTC type for two-wire screened connection to the associated controllers.

1.118.2 Sensors shall consist of a baseplate to which the electrical connections are made. The sensor housings shall plug into the base such that it can be removed easily without disturbing any wiring connections.

1.119 Sensors (Immersion)

1.119.1 All immersion sensors shall consist of a rugged die cast aluminium baseplate which rigidly holds an immersion tube, a minimum of 76mm in length with "BSPT" screwed connection. A clamp-on protection shall cover the cable connection that shall be suitable for a two-wire connection. It shall be possible to replace the sensor without the system.

1.120 Fan Lockout Thermostat

1.120.1 Where detailed elsewhere in this Specification or on the Contract Drawings, air handling units shall have a fan lockout thermostat to protect the water coils from freezing.

1.120.2 The thermostat shall comprise of a remote mounting switch with a 6mm capillary serpentined across the duct, downstream of the first heating coil. The thermostat shall have a SPDT volt-free switch, which in the event of a frost condition being detected shall lockout, stop the supply fan and require manually re-setting. The capillary shall be supported by the clips provided.

1.121 Air Pressure Switches

1.121.1 All pressure switches shall comprise two chambers connected to a diaphragm. The chambers of the device shall be arranged such that the device can be used as a static pressure or differential pressure switch as detailed elsewhere in this Specification or on the Contract Drawings.

1.121.2 Connections to the devices shall be by means of plastic tubes to the points to the points to be measured on the duct, via a plastic separated coupling. The pressure switches shall have SPDT volt-free switch and be supplied complete with duct sampling connections and plastic connecting pipes.

1.122 Control Valves

1.122.1 For accuracy of control all modulating main plant valves up to 100mm used for hot and chilled water service shall be of the magnetic type with a speed of response not exceeding 1 second and range ability of at least 500:1 at valve design flow. All valves shall incorporate a pressure balancing bellows.

1.122.2 Valve bodies shall be cast iron, and seats and inner valve material shall be chrome nickel steel. Valve sizes 2" and smaller shall be screwed and supplied with union fittings. Valves sizes above 2" shall be flanged.

1.122.3 Valves shall be the 3 way or straight through type as required. The valves shall be equipped with a hand wheel to allow for manual positioning of the valve in the absence of control power. Valves shall be of the spring return type that shall move to the bypass position on power failure.

1.122.4 Valves shall be supplied complete with actuators and linkages and shall be supplied to site ready assembled and adjusted for stroke.

1.123 Packaging and Protection

1.123.1 All equipment shall be suitably packaged and/or protected for transit and storage on site. The mechanical control panels shall be suitably crated in timber boxes and further protected internally with bubble wrap or similar. An envelope of 500 grade anti-static polythene shall enclose the equipment. All joints in the polythene shall be welded or jointed with heavy-duty staples.

1.123.2 Additional protection shall be provided to the panel corners by the use of adhesive tape. Instructions for correct handling shall be clearly marked on the exterior of the packaging.

1.123.3 The Contractor shall be responsible for the protection of all equipment prior to and during installation, from weather and site conditions.

1.123.4 All fixings and entries shall be made weather tight to ensure that building materials, dirt and waste, etc. cannot enter. In any instance where dirt or dust is found in the equipment the Contractor shall clean and refurbish the equipment to the satisfaction of the Contract Administrator, or replace the equipment should deterioration be found to have taken place.

1.124 Commissioning and Testing

1.124.1 General

1.124.2 The Contractor shall carry out testing and commissioning of the installation in accordance with the details of this Specification, and the CIBSE / BSRIA Commissioning Codes / Guidelines.

1.124.3 It shall be the Contractor's responsibility to put the installation to work, and to demonstrate the correct operation of all parts thereof in accordance with the Contract Drawings and this Specification.

1.124.4 In addition, the Contractor shall carry out, to the satisfaction of the Contract Administrator, the testing and inspection procedures specified in the current edition of the CIBSE Commissioning Guides, and all other tests required by this Specification.

1.124.5 On satisfactory completion of the Commissioning Procedures the Contractor shall issue test certificates as prescribed in the CIBSE Commissioning Guides, British Standards and herein.

1.124.6 Where required by the Contract Administrator, the Contractor shall, without cost or delay to the Contract, employ an independent external specialist commissioning company to undertake the testing specified herein.

1.124.7 The testing of specialist systems such as chillers, boiler plant etc. shall be undertaken by the system manufacturers or their appointed agents, under the direction of the Contractor.

1.124.8 Only when a system is fully complete, tested and commissioned shall it be offered for witnessing by the Contract Administrator. No system shall be deemed complete and acceptable without the approval of the Contract Administrator. Should a system be offered as complete and be rejected by the Contract Administrator more than twice, then the Contractor shall reimburse the Contract Administrator and all other parties involved for their costs incurred by subsequent witnessing.

1.124.9 The Contractor shall ensure that all testing and demonstration of systems and equipment is undertaken by suitably qualified and experienced personnel. Should the Contract Administrator require additional or replacement personnel they shall be provided immediately, and without delay or cost to the Contract.

1.124.10 It shall be the Contractors responsibility to provide all test instruments, dummy loads etc. required for testing and commissioning. All such instruments shall remain the property of the Contractor.

1.124.11 The Mechanical Services Contractor shall be responsible for the coordination of all commissioning activities on the Project including the programming, direction and coordination of the Electrical Services Contractor.

1.125 Setting to Work

1.125.1 The complete installation, or such parts thereof which may be required to be commissioned separately, shall be set to work by the Contractor. All partial setting to work shall be subject to the agreement of the Contract Administrator.

1.125.2 Prior to operation of any plant, the Contractor shall remove all waste, rubbish, etc., and direct the Main Contractor to clean out all builders work ducts, plant spaces, maintenance access spaces etc. The Contractor shall blow out and clean all airways, casings, panels and switchboards. No air system shall be operated until building works are complete in the area served.

1.125.3 The cleanliness of all areas shall be subject to the approval of the Contract Administrator.

1.125.4 The Contractor shall ensure all necessary fuel, electricity and water supplies are available in a timely manner.

1.126 Commissioning Specialist

1.126.1 Where detailed elsewhere in this Specification or directed by the Contract Administrator, the Contractor shall employ a specialist commissioning company to carry out and coordinate commissioning of the installation. This role shall be comprehensive, encompassing all aspects of the Mechanical Services installation.

1.126.2 The specialist commissioning company shall coordinate the activities of all parties required for the commissioning and testing of the works.

1.126.3 The specialist commissioning company shall provide advice throughout the duration of the installation on the optimum locations of balancing devices, controls, fill points, etc.

1.126.4 As soon as practicable, and no later than 4 weeks prior to the setting to work of all or part of the installation, the specialist commissioning company shall issue a detailed commissioning programme and method statement to the Contract Administrator for comment. The following shall be identified, as a minimum:

1.126.5 Key dates, e.g. power-on to each item of plant.

1.126.6 Critical path interfaces between specialists, manufacturers and other trades. Air/water balance dates.

1.126.7 Schedule of proposed plant and systems test sheets/certificates. Samples of commissioning test sheets.

1.126.8 All plant and specialist equipment, e.g. boilers, chillers, etc. shall be set to work and commissioned by the individual manufacturer's commissioning agents, under the direction of the specialist commissioning company.

1.127 Commissioning Criteria

1.127.1 General

The Contractor shall carry out testing and commissioning of the installation in accordance with the details of this Specification, and the CIBSE Commissioning Guides.

1.127.2 Water Systems

1.127.3 All water systems shall be balanced to the following criteria: Terminal units where flow rate is < 0.1 l/s: 10% AHU coils, where the flow rate is > 0.1l/s: 0% to + 10%. Branches: 0% to + 10% Mains: 0% to + 10%

1.127.4 Where systems are subject to an initial proportional balance, the Contractor shall measure and demonstrate the final system flow rates, including to terminal devices, in accordance with the tolerances stated above to the approval of the Contract Administrator.

1.127.5 Air Systems

1.127.6 All air systems shall be balanced in accordance with the criteria stated in the CIBSE Commissioning Code A.

1.127.7 Plant

1.127.8 All boiler plant shall be commissioned in accordance with CIBSE Commissioning Code B. All refrigeration plant shall be commissioned in accordance with CIBSE Commissioning Code R.

1.127.9 Instrumentation

1.127.10 All instrumentation used for the purposes of measuring plant, equipment and system performance shall have their details, including manufacturer, type, serial number and calibration date, recorded on the test sheets.

1.127.11 All instrumentation shall have current calibration certificates, copies of which shall be included in the O & M manuals.

1.127.12 Demonstration of Results

1.127.13 The Contract Administrator will not issue a Practical Completion Certificate until the complete installation has been satisfactorily demonstrated.

1.127.14 Only when the Contractor has completed the commissioning of the installations, or complete sub-systems thereof, to meet the specified criteria, shall he request the Contract Administrator to witness the system(s) performance.

1.127.15 The Contractor shall give the Contractor Administrator a minimum of seven days' notice of such demonstrations. The Contractor shall provide all facilities for the Contract Administrator to witness and check all tests.

1.127.16 Where sub-systems have been demonstrated separately, the Contractor shall further demonstrate that the complete installation is capable of simultaneous operation to the approval of the Contract Administrator.

1.127.17 If at the time of demonstration it is not possible to operate portions of the installation under full load conditions, the Contractor shall repeat those portions of the tests under full load conditions at an appropriate time within the defects liability period at no extra cost to the Contract.

1.128 Environmental Tests

1.128.1 Unless noted otherwise elsewhere in this Specification, the Contractor shall carry out the following environmental checks prior to Practical Completion. They shall be carried out with all plant operating in a fully automatic state, with the areas under test clear of all personnel and with all doors and windows closed.

1.129 Room Temperature and Humidity Levels

1.129.1 All room temperature and humidity level tests shall be conducted over continuous seven- day periods.

1.129.2 Temperatures and humidity levels shall be recorded for every zone and elevation for open plan areas, and every individual room for cellular arrangements.

1.129.3 Sample measurements shall be taken a minimum of 2No. times per day. In addition, thermohydrographs shall be provided, with seven-day charts. A minimum of 2 No recorders per floor on every other floor shall be provided.

1.129.4 Outside air temperatures and humidity levels shall be recorded over the same period.

1.130 Noise levels

1.130.1 Sound pressure level measurements shall be taken in all areas, with all plant operating at its specified duties.

1.131 Results

1.131.1 The Contractor shall issue to the Contract Administrator for approval 2 No copies of a bound report, documenting the following:

- Methods of tests Measurement positions Dates and times of tests Test results
- Thermohydrograph charts, dated and indexed against location plans
- Test equipment details

1.131.2 The final draft of the report shall be incorporated into the O & M manuals, as detailed elsewhere in this Specification.

1.131.3 The individual tests shall be as detailed elsewhere in this Specification, and as follows:

- Hydraulic pressure tests
- Ductwork pressure tests
- Air balance tests
- Air volume tests
- Air system resistance tests
- Water balance tests
- Water volume tests
- Water system resistance tests
- Fan tests
- Pump tests

1.131.4 All test sheets shall be submitted to the Contract Administrator for approval, prior to practical completion.

1.131.5 Certified flow and pressure test results throughout the system shall be recorded on air and water system schematic record drawings.

1.131.6 Requirements and Procedures

1.131.7 The Contractor shall conduct tests before, during and at the completion of the installation and on completion of the maintenance period, as and when required by the Contract Administrator. In particular, the Contractor shall ensure compliance with the detailed requirements of this Specification and the following:

1.131.8 All testing shall be agreed with the Contract Administrator, due notification being given of the date on which the various tests are to be conducted, so that the Contract Administrator may be present to witness them. Failure to notify that tests will be carried out shall necessitate re-testing in the Contract Administrator's presence without additional cost or delay to the contract.

1.131.9 All testing equipment, instruments, etc. and labour necessary for carrying out the test shall be provided by the Contractor.

1.131.10 Off Site Testing

1.131.11 The Contractor shall be responsible for arranging off-site tests at no additional cost to the Contract.

1.131.12 All cables, materials and equipment shall be tested in accordance with the details given below:

- Complete switchgear equipment - routine and type test.
- Earthing devices - routine and type tests. Materials - sample tests.
- Control panels - routine tests. Details of tests shall be as follows:

1.131.13 Complete Switchgear Equipment

1.131.14 In addition to the manufacturers other routine tests, the manufacturer shall, on request by the Contract Administrator, demonstrate to the full satisfaction of the Contract Administrator, that each fuse switch, circuit breaker and contactor is operated ten times in the normal manner.

1.131.15 The type test shall comprise an electrical heating test, making and breaking capacity test, a mechanical endurance test, followed by an earth fault leakage test.

1.131.16 Where test certificates are available for switchgear equipment, the above tests may be waived at the option of the Contract Administrator, provided that the manufacturer satisfies the Contract Administrator that the equipment will operate properly under the conditions of service.

1.131.17 Earthing Devices

1.131.18 Earthing devices shall, where required by the Contract Administrator, be demonstrated to his satisfaction. This shall comprise a resistance test of the panel earthing system, and an operational test of all associated devices.

1.131.19 Materials

1.131.20 The Contract Administrator reserves the right to witness sample tests on any materials specified.

1.131.21 Control Panels

1.131.22 In addition to the manufacturers other routine tests, an insulation test shall be carried out at a voltage of 2kV to earth, for a period of one minute.

1.131.23 The manufacturer shall satisfy the Contract Administrator that the equipment will operate in accordance with functional description.

1.131.24 The Contractor shall provide certification of all switchgear and control panels by an internationally recognised testing laboratory.

1.131.25 On Site Testing

1.131.26 In addition to all the tests as described in the requirements of the IEE regulations, the Contractor shall carry out the following tests:

1.131.27 Metal Conduit and Steel Trunking:

1.131.28 The Contractor shall take tests of the continuity of the conduit as installation proceeds. Written records of all tests shall be sent to the Contract Administrator.

1.131.29 Verification of Polarity:

1.131.30 Tests shall be carried out to ensure that single pole lighting switches, switched socket outlets and fuses are in the live conductor.

1.131.31 Effectiveness of Earthing Conditions:

1.131.32 Tests shall be carried out to determine the impedance of the protective conductors between the earthing terminal and the farthest ends of the sub-circuits.

1.131.33 Earth Fault Loop Impedance Test:

1.131.34 The complete installation shall be tested by means of a phase-earth loop impedance tester of the current injection type.

1.131.35 Insulation resistance:

1.131.36 In all LV circuits insulation resistance shall be measured by means of a 500-volt insulation tester. Tests shall be made between conductors and from each conductor to earth, and each test duly recorded.

1.131.37 A minimum reading of 10 megohms is required for each final sub-circuit. Phase Rotation:

1.131.38 Tests shall be made to demonstrate to the Contract Administrator the phase rotation of all 3-phase distribution systems. The phase rotation of all switchboards, distribution boards and rising main bus bars etc. shall be red, yellow and blue left to right and/or top to bottom when facing the equipment.

1.131.39 Fuses and Miniature Circuit Breakers:

1.131.40 Characteristic curves of fuses and miniature circuit breakers shall be supplied to the

1.131.41 Contract Administrator for his approval by the Contractor on request.

1.131.42 Lamps and Fluorescent Tubes:

1.131.43 The Contractor shall demonstrate the lamps and fluorescent tubes are of correct type and rating, and the correct polarity of ES and BC lamp holders.

1.131.44 Motors and Motor Starter Contactors:

1.131.45 The Contractor shall demonstrate that all motors run in the correct direction or rotation and each motor is properly protected by protective devices of correct rating as specified.

1.131.46 The Contractor shall measure and record the normal load running current of each motor connected under this Contract whether supplied by him or others. Duplicate copies of readings shall be issued to the Contract Administrator for approval.

1.131.47 Accessories:

1.131.48 Tests shall be carried out on all completed installations to demonstrate that all switches are connected in the live conductors, that all socket outlets and spur units are correctly connected and that all switches and outlets operate the apparatus to which they are connected satisfactorily.

1.131.49 Records of Testing and Test Sheets

1.131.50 Records shall be made of all tests carried out. Duplicate copies of test sheets giving full information shall be sent to the Contract Administrator within seven days of the tests being carried out.

1.131.51 Sample test sheets shall be submitted to the Contract Administrator for approval within twenty-eight days of appointment.

1.131.52 Commissioning and Setting to Work of Control Systems

1.131.53 General

1.131.54 Commissioning and testing of the controls shall be carried out by the Controls Specialist in accordance with the recommendations and procedures issued by the Chartered Institute of Building Services Engineers.

1.131.55 Pre-Commissioning Checks

1.131.56 All field wiring shall be tested prior to termination at the control panel or point of use. Prior to setting any plant or equipment into operation, the Controls Specialist shall check that all plant and equipment is in operational condition with all drives correctly adjusted and all systems fully charged.

1.131.57 The Controls Specialist shall be in attendance whilst specialist items of equipment (e.g. water chillers, boilers, pressurisation units, etc.) are checked and commissioned by their manufacturers commissioning agents.

1.131.58 The Controls Specialist shall ensure that all fuse and protective devices are of the correct type, rating and/or setting, including those not of his supply, but which are associated with his work (e.g. switchboard fuse ratings). Furthermore he shall ensure that all covers are securely located on all sensors, actuators, motor connection boxes, and other electrical apparatus associated with his work.

1.131.59 Prior to electrically energising any part of the control systems, a pre-check report shall be issued to and accepted by the Contract Administrator confirming that the controls and services are safe to electrically energise and operate.

1.131.60 A schedule defining all desired values and set points shall be issued to the Contract Administrator so that he may confirm their values.

1.131.61 On completion of manufacture, but prior to delivery to site, each control panel shall be fully tested at works in the presence of the Contract Administrator or his appointed agent. The tests shall demonstrate that the apparatus and the panel as a whole meet with the requirements of the IEE.

1.131.62 Regulations and that all logic and control interlocks, including switches and lamps operate correctly.

1.131.63 Commissioning and Testing

1.131.64 All control and other user definable variables and adjustments shall be set initially to provide the desired values indicated by the Contract Administrator. Where it is found necessary to alter a value in the light of operational experience, this shall only be with the agreement of the Contract Administrator.

1.131.65 The controls shall be dynamically adjusted to provide the required values and the design conditions when the services are operating in both their normal modes and in their identified abnormal or fault modes of operation (e.g. smoke evacuation, fault condition, etc.).

1.131.66 The Controls Specialist shall demonstrate to the Contract Administrator that the operation of each control loop is capable of giving the required conditions within the required limits over the required range of input variables.

1.131.67 The Controls Specialist shall demonstrate to the Contract Administrator that the operation and action of all operational and safety interlocks are correct, both on an individual and an overall basis.

1.131.68 The Controls Specialist shall prepare and issue to the Contract Administrator a comprehensive schedule identifying the values of all settings and adjustments to all control and other variables including the ratings of all fuses, overload heaters, etc., and the measured full load currents of all motors supplied from his panels. The values given shall be the value indicated on the calibration scale of the instrument or apparatus. Where no calibration scale exists, the value shall be given in terms of a percentage of the total adjustment or displacement range from one identified datum point or extreme position.

1.131.69 Hard copies of all control strategies shall be handed over on completion.

1.131.70 Wiring Diagrams and Schematics

1.131.71 General Requirements

1.131.72 The Controls Specialist shall prepare all necessary wiring diagrams and schematics of the internal wiring of the panels and the external field wiring.

1.131.73 All components shown on the diagrams shall be uniquely referenced using an alpha- numeric code, the alpha part identifying the components generic type. All cable codes shall be identified, as shall all terminal codes. The last number used for each code type shall be listed and shown on the first sheet of each diagram.

1.131.74 Diagrams and schematics shall carry a numbered grid that shall be used to identify the locations of components on the drawings. Contactor, timer and relay coils shall identify the number of contacts used and where they can be found on the drawings. As a further cross reference for ease of use, each drawing shall contain an alpha-numerically ordered schedule listing the sheet and the grid co-ordinates of all components shown on the drawings.

1.131.75 All components shall be drawn in their de-energised states and/or default positions. A convention shall be adopted to show all moving contacts in the vertical plane and moving from right to left on energisation.

1.131.76 A clear convention of symbols shall be rigorously employed on the drawings. A full legend of all symbols used shall be provided on the first sheet of each drawing.

1.131.77 When a diagram extends over more than one sheet, each line continuing from one sheet to another shall have a common identity code on both sheets, together with an indication of the sheet number on which the line is continued and its position in the sheet.

1.131.78 Where cables are shown connecting to other items of equipment, the diagram shall clearly identify the terminals to which they connect and state the source, drawing number and revision on which the information was based. Where necessary, explanatory notes or extract from the other party's wiring diagrams shall be added to clarify the function and purpose of the inter-connections.

1.131.79 Panel Layout

1.131.80 Fully dimensioned panel layout drawings shall be prepared showing the internal and external layouts of the panels and the equipment and components mounted within and on them. The drawings shall also show the proposed positioning, wording and letter sizes of all labels.

1.131.81 Guarantees

1.131.82 All magnetically-actuated control valves shall have a five year manufacturer's guarantee. There shall be the option of a similar five years guarantee on all the controls manufactured by the controls manufacturer.

1.131.83 Implementation

1.131.84 The automatic control system shall be designed, manufactured and supplied by the same controls manufacturer. The whole system shall be checked and put into operation by the controls manufacturer upon completion of the installation.

1.131.85 The siting of items of control equipment shall be such that access for adjustment and maintenance purposes is not impeded. However, where items of control equipment are mounted in accessible positions within normally occupied areas, the control items shall be provided with means to discharge unauthorised interference.

1.131.86 Control systems shall be arranged such that, in the event of electrical power failure or other abnormal operating conditions, inherent fail safe features prevent potentially conditions arising hazardous.

1.131.87 Firefighting and essential circuits shall be controlled via hard-wired control interlocks (non-software driven). Control functionally shall be fail safe mode.

1.131.88 The controls manufacturer shall guarantee long term system care and provide regionally based service and spare parts capabilities.

1.131.89 Control Equipment Manufacturers

1.131.90 All equipment used in the manufacture of mechanical services control panels shall be as detailed in the schedules elsewhere in this Specification.

1.131.91 Spares

1.131.92 The Contractor shall provide short and long term spares lists, which shall form part of Operating and Maintenance manuals.

1.131.93 The Contractor shall also supply the following spares at handover:

1.131.94 3 No examples of all fuse types and ratings used in any control panels provided under this Contract. They shall be enclosed in either a wall-mounted enclosure or a cubicle forming part of the control panel, as detailed elsewhere in this Specification or on the Contract Drawings.

1.131.95 No replacement for each type of control panel indicator lamp used on this Contract. They shall be enclosed along with the above-specified fuses.

1.131.96 A complete set of replacement drive belts of each size and type used on this Contract, individually identified.

1.131.97 One complete set of spare filter media for air handling plant

1.131.98 Earthing and Bonding

1.131.99 The earthing and bonding of all mechanical services plant and equipment, including bridges across flexible pipe or ductwork joints, etc. shall be undertaken by the Electrical Services Contractor.

1.131.100 The Mechanical Services Contractor shall be responsible for ensuring that all necessary connection studs, holes etc. are provided to facilitate this work. The Contractor shall provide all necessary liaison and attendances as may be required to facilitate the earthing and bonding works, including allowances for same in working programmes.

1.131.101 Pipework & Materials General (Water Services)

1.131.102 The whole of the materials to be used in this contract shall be of the best quality of their respective kinds, and where such exists the material shall conform to the latest British Standard specification and be approved by the Water Research Council. Materials are to be purchased from a manufacturer approved by the Services Engineer.

1.131.103 Where British Standards and Code of Practice Publications are cited, such shall be deemed to refer to the current editions.

1.131.104 All pipework and fittings used in the construction of the various systems described shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws and shall be free from scale in the case of ferrous materials.

1.131.105 All pipework used shall be new and for ferrous materials shall arrive on site colour banded to identify different grades.

1.131.106 All pipework stored on site shall at all times be arranged with adequate facilities for prevention of damage or rusting. Pipework shall not be left lying on the ground.

1.131.107 All pipework and fittings shall be installed with sufficient and adequate fixings, and with due consideration for expansion, insulation, prevention of rusting or damage to the building fabric or finishes and for appearance and subsequent access.

1.131.108 In occupied spaces, such as offices pipework shall follow the contours of the walls, floors and ceilings where exposed to view. Where two or more pipe runs follow the same routes care shall be taken to ensure that all are parallel to each other and to the building structure where applicable, except for the required allowance for venting, etc.

1.131.109 No joints of any kind shall be made within the thickness of walls, floors or ceilings, unless the indicated design makes this unavoidable.

1.131.110 During the course of the contract, all open ends shall be plugged or capped, to prevent the ingress of dirt with purpose made plastic, metal or wooden plugs. The use of paper or cardboard will not be permitted.

1.131.111 Sufficient unions and flanges shall be installed in screwed and soldered pipework to allow subsequent removal of any section of pipework without damaging the building fabric.

1.131.112 Where pipes pass through walls, floors or ceilings, a sleeve of similar material to the service pipe such as copper sleeve for copper service and mild steel for galvanised pipework or other approved tube, shall be provided such as to allow the free movement of the pipes. The exception shall be plastic pipes where metal sleeves shall be provided. Sleeves shall be of such a length as to finish 2 mm proud of finished surfaces. Alternatively, where indicated on the drawings puddle flanges shall be provided on the pipework.

1.131.113 Non-ferrous couplings or fittings shall be used where necessary to prevent electrolytic action between copper pipework and galvanised or steel equipment or fittings.

1.131.114 Jointing of pipework shall be made using water authority approved materials. In no instance shall solder or fittings containing lead be installed in domestic water systems.

1.131.115 Underground pipes shall be wrapped in 'Denso Tape' or equal anti-corrosion tape where necessary and buried with a minimum cover of 750mm.

1.131.116 All pipes are to be carefully graded to falls to facilitate draining and removal of air. Air release bottles and cocks shall be fitted in an accessible manner at all high points. Vents of the automatic float type shall be provided at such high points as particularly specified or where the air bottles type is not applicable.

1.131.117 Drain valves shall be fitted at all low points to facilitate draining the system or points thereof.

1.131.118 Pipework & Materials General - (Sanitation & Rainwater)

1.131.119 The whole of the materials to be used in this contract shall be of the best quality of their respective kinds, and where such exists the material shall conform to the latest British Standard Specification and be acceptable to the Local Authorities. Materials are to be purchased from a manufacturer approved by the Services Engineer.

1.131.120 Where British Standards and Code of Practice Publications are cited such shall be deemed to refer to the current editions.

1.131.121 All pipework and fittings used in the construction of the various systems described shall be straight, cleanly finished, round in cross section, free from cracks and surface flaws.

1.131.122 All pipework used shall be new and shall arrive on site suitably marked to identify different grades.

1.131.123 All pipework stored on site shall at all times be arranged with adequate facilities for prevention of damage or rusting. Pipework shall not be left lying on the ground.

1.131.124 All pipework shall be free from burrs, rust and scale and shall be thoroughly cleaned before installation.

1.131.125 All pipework and fittings shall be installed with sufficient and adequate fixings, and with due consideration for expansion, insulation, prevention of rusting or damage to the building fabric or finishes and for appearance and subsequent access.

1.131.126 In occupied spaces, such as offices pipework shall follow the contours of the walls, floors and ceilings where exposed to view. Where two or more pipe runs follow the same routes care shall be taken to ensure that all are parallel to each other and to the building structure where applicable, except for the required allowance for venting etc.

1.131.127 No joints of any kind shall be made within the thickness of walls, floors or ceilings, unless the indicated design makes this unavoidable.

1.131.128 During the course of the contract all open ends shall be plugged or capped to prevent the ingress of dirt or building materials with purpose made wooden plugs. The use of paper or cardboard will not be permitted.

1.131.129 Where pipes pass through walls, floors or ceilings, a sleeve shall be provided of a similar material to the pipe used. Where no sleeves are required they are as to be cast in the floor slab, the pipes shall be wrapped with building paper fixed with masking tape or galvanised wire to allow free movement of the pipe. The sleeves or building paper shall finish 2 mm proud of finished surfaces. Alternatively, puddle flanges shall be provided to the pipework where indicated on the drawings.

1.131.130 Underground pipework where installed in copper shall be wrapped in 'Denso Tape' or equal, to prevent corrosion.

1.131.131 All pipes are to be carefully graded to falls as indicated on the drawings or codes of practice to facilitate the correct self-cleaning velocities, etc. and self-draining in the case of ventilation pipework.

1.131.132 All the installation of the different systems shall be carried out in accordance with the requirements and regulations of the Local Authority, and in accordance with BS EN 12056.

1.131.133 All pipework shall be installed truly vertical. Pipes shall be weathered through the roof using proprietary materials to give a weatherproof joint with open end provided with a cowl to prevent ingress of foreign material.

1.131.134 Where a pipe of a combustible material passes through a fire break wall, it shall be provided with suitable fire protection where applicable to meet the building regulations. All the pipework shall be adequately fire stopped.

1.131.135 Adequate precautions are to be taken where pipe runs passed under a construction joint. Proprietary flexible joints are to be provided on either side.

1.131.136 Access shall be provided at the base of all soil and rainwater stacks and where indicated on the drawings to provide adequate maintenance in the event of blockage. All access doors or fittings shall be positioned in such a manner that they can be conveniently inspected and cleared at all times, they shall be provided with soft rubber or neoprene gaskets. Where access points provided to pipework are concealed the shaft or ceiling shall be provided with an appropriate opening.

1.131.137 All traps provided to sanitaryware shall be of the deep seal tubular two piece pattern unless specified elsewhere in the Sanitary Appliance Schedule issued to the requirement of the Architect.

1.131.138 Offsets in soil stacks shall only be installed where indicated on the drawings.

1.132 Cast Iron Pipework & Fittings - (Sanitation & Rainwater)

1.132.1 All cast iron pipes and fittings shall comply with BS 416 for soil pipes and BS 437 for drain pipes using socketless pipes and fittings.

1.132.2 The joints shall be made using mechanical joints to BS EN 877 electrical continuity type where required.

1.132.3 Connection to WC outlets shall be made using a 'Multikwik' connector or equal and approved, with the appropriate size WC adapter.

1.132.4 Any work which the Services Engineers requires additional brackets to prevent misalignment or movement by other or following trades shall be provided at no additional cost to the contract.

1.132.5 Particular care is to be given when making mechanical joints with particular emphasis on the torque setting requirement.

1.132.6 Connections through roof shall be made using a cast iron roof connector fitted with a copper balloon. The bottom of the roof connector cowl shall be positioned 150mm above the roof finish.

1.132.7 The pipe shall pass through a weathering slate constructed from Code 6 sheet lead with a minimum base size of 400 mm square, all joints to be double lap lead burnt.

1.132.8 On refurbishment work where caulked lead joints specified, these shall be made with yarn and virgin pig lead well rammed and finished with bitumastic paint.

1.133 UPVC Pipe & Fittings - (Sanitation & Rainwater)

1.133.1 All UPVC pipe and fittings shall comply with BS 4514, 5255 and 4576 using 'Terrain' or equal approved.

1.133.2 Where UPVC drain pipe and fittings are used these shall comply with BS 4660. Wash basins and sink wastes shall comply with BS EN 274 Parts 1 to 3.

1.133.3 Plastic waste traps shall comply with BS EN 274.

1.133.4 All joints shall be made using solvent welded fittings. 'O' ring joints will be only used where necessary to allow expansion to the pipework.

1.133.5 Thermal movement shall be alleviated by allowing 15 mm in the depth of the socket between the spigot of the pipe and the shoulder of the 'O' ring socket.

1.133.6 'O' ring sockets shall be provided for the purpose of expansion in accordance with the manufacturer's fixing instructions, generally between fixed points, boss connections to stacks, and every 1.8 metres on waste and anti-syphon pipework.

1.133.7 All expansion joints must be provided with a fitting support to give resistant against thermal movement.

1.133.8 Connections through roofs shall be made using a UPVC weathering apron the bottom of which shall be 150 mm above the roof finish and shall be fitted with a UPVC vent cowl.

1.133.9 The pipe shall pass through a weathering slate obtained from the pipe manufacturer.

1.133.10 All UPVC pipes passing through fire rated floors and walls where required by the Fire Authority or the building regulations shall be provided with steel sleeves or approved fire protective wrapping extending 1000mm either side of the floor or wall. As an alternative, the pipe shall be fitted with an approved intumescent fire sleeve, which shall be installed in accordance with the manufacturer's instructions.

1.134 UPVC & CPVC Pipework & Fittings - (Water Services)

1.134.1 All UPVC and CPVC pipes shall be suitable for use with potable water and be WRC approved.

1.134.2 The UPVC and CPVC pipework manufacturer selected by the Contractor for installation shall be approved by the Engineers prior to the ordering of materials.

1.134.3 In the case of cold water systems, pipes and fittings shall comply with BS 3505.

1.134.4 Pipes and fittings used for hot water services pipework shall have an agreement certificate of approval.

1.134.5 UPVC and CPVC pipes and fittings shall be jointed using the manufacturer's solvent weld and where necessary, by approved compression joints. Pipes shall be jointed strictly in accordance with the procedures specified by the manufacturer, and joints shall be left undisturbed for the correct period of time. All joints shall comply with the relevant provisions of BS 4346 Parts and 2.

1.134.6 Valves and cocks used as part of the UPVC and CPVC pipework systems shall be gunmetal or brass as specified elsewhere.

1.134.7 The Contractor shall make full allowance for expansion in the pipework system either by expansion loops or joints which shall be fixed with the manufacturer's recommendations.

1.134.8 The solvent weld used for jointing UPVC pipes shall comply with BS 4346 Part.

1.135 Copper Pipework & Fittings - (Sanitation & Rainwater)

1.135.1 All Copper pipes shall be light gauge Class X complying with BS EN 1057 R250 supplied in random lengths between 4.5 and 6.0 metres each and fitted with a protective cap.

1.135.2 Copper pipes installed above ground up to and including 54m in size are to be jointed with capillary type fittings to BS 864 Part 2/BS EN 1254 Parts 1 and 2. They should be cut to the required length and cleaned with fine steel wool.

1.135.3 Copper pipes installed above ground above 54m in diameter and below ground are to be jointed with compression fittings to BS 864 Part 2/BS EN 1254 Parts 1 and 2, Type A. They shall be cut to the required length all swarf filings and dross then being carefully removed, and the ends then cleaned.

1.135.4 As an alternative to Item 3, pipework above 54m diameter can be jointed with bronze welded fittings or silver brazing, provided that a qualified and experienced welder is used. Bronze welding shall conform to the requirements of C2 or C4 of BS 1453.

1.135.5 Bends, sets and springs are to comply with good modern standard practice and shall be annealed before fixing into position.

1.135.6 All soldered joints must be lead free including capillary fittings.

1.136 Steel Pipework & Fittings (Water Services)

1.136.1 All mild steel pipes up to 150mm bore, shall comply with BS 1387, medium or heavy quality as required, supplied in random lengths of between 4.5 and 7.5 metres.

1.136.2 Where pipes are required for screwed joint they shall be provided with screwed taper threads to BS 21 Part 1.

1.136.3 All mild steel pipes above 150mm bore shall be to BS 806 with a wall thickness of approximately 7 mm supplied in random lengths of up to 7.5 metres, or cut to length to suit site measurements.

1.136.4 Pipes shall in all cases be provided with plain ends cut to a level as may be required for use with slip on flanges.

1.136.5 Screwed pipework joints shall be made using WRC approved materials such as long stranded hemp and approved white jointing compound to BS 5292/BS 6956 Parts 1, 5, 6 and 7. All surplus material being finally cleaned off to leave a surface suitable for painting.

1.136.6 Fittings are to be banded or beaded pattern to BS 1256.

1.136.7 At dismantling points and at connections to appliances, ground in spherical seated unions shall be used.

1.136.8 Bushing shall not be permitted in pipe runs, reductions in size being made only by the use of reduced fittings.

1.136.9 Eccentric reduced fittings shall be used on all horizontal pipework arranged to give a smooth run to the crown of the pipe. Concentric reduced fittings shall be used on vertical pipework.

1.136.10 Flanged pipe joints shall be to BS EN 1092-2 corresponding to the working pressure of the installation.

1.136.11 The joint between the flanges shall be made with WRC approved materials.

1.136.12 Bolts shall have the minimum tensile strength of 430 MN/m squared and all nuts shall have a washer under them with no more than two threads showing.

1.136.13 All mild steel pipes are to be hot dipped galvanised to comply with BS 4921 and the special provisions of BS 1387.

1.137 Blue Polythene Pipes & Fittings

1.137.1 Blue polyethylene pipe up to nominal size 63 for below ground use for cold potable water shall comply with the relevant provisions of BS 6572/BS EN 12201 Parts 1, 2 and 5.

1.137.2 Polyethylene pressure pipe for cold potable water in nominal sizes greater than 63 shall comply with the relevant provisions of information and Guidance Note No. 4-32-03 issued by the WAA Sewers and Water Mains Committee.

1.137.3 Polyethylene fusion and fittings for use with cold potable water pressure pipes shall comply with the relevant provisions of information and Guidance Note No. 4-32-04 issued by the WAA Sewers and Water Mains Committee.

1.138 Pipework & Equipment Testing

1.138.1 Test Pressures

1.138.2 Water Services 1.5 X Working Pressure but not exceeding 9 bar to the satisfaction of the

1.138.3 Water Authority and Services Engineers.

1.138.4 Sanitary Pipework Test Pressure 38mm Water Gauge for a duration of 3 minutes in accordance with BS EN 12056 and to the satisfaction of the Local Authority.

1.138.5 Rainwater and condensate 38mm water gauge for a duration of 3 minutes in accordance with BS EN 12056 and to the satisfaction of the Local Authority.

1.138.6 Dry riser test pressures 10 bar measured at the inlet for a period of 15 minutes in accordance with BS 5306 Part 1 and to the satisfaction of the Local Authority.

1.138.7 Wet riser shall be tested to 1.5 x the working pressure for a period of one hour in accordance with BS 5306 Part 1 and to the satisfaction of the Local Authority.

1.138.8 A flow test shall also be carried out for wet and dry risers if required by the Local Authority.

1.138.9 The Contractor shall provide all labour, equipment and materials to execute this section of the works.

1.138.10 No pipework shall be insulated or buried until the pressure tests have been witnessed and passed by the Services Engineer.

1.138.11 All plugs, caps, tees and drain fittings required to enable the tests to be carried out, are to be supplied by the Contractor, together with the whole of the testing apparatus and water.

1.138.12 The Contractor shall allow for testing the necessary installations in whole or in part as necessary to facilitate the progress of the Works to other trades or to enable the Works to be commissioned in sections and no extra cost will be allowed for testing in part.

1.138.13 Any fault discovered during such tests shall be at once remedied by the Contractor at his own expense and the test re-applied until the Services Engineer or his representative is satisfied that the section under test is sound.

1.138.14 All tests shall be witnessed by the Services Engineer or such other persons who shall be nominated by him to witness the tests.

1.138.15 Prior notification of all site tests shall be given to the Services Engineer giving at least 5 working days' notice.

1.138.16 Any existing pipework intended for retention shall satisfy the test criteria above.

1.138.17 Pipe Grading (Water Services Pipework)

1.138.18 All pipes shall be carefully graded to a rise or fall to facilitate the removal of air and for the complete draining of lines for maintenance purposes.

1.139 Overflows

1.139.1 Overflows from WPPs shall discharge via purpose made proprietary overflow tundish in the position and manner as detailed on the drawings.

1.139.2 Tank overflows and warning pipes are to be installed to the model water byelaw requirements and to the size shown on the drawings.

1.139.3 The Contractor is to ensure that the installation complies with the British Standard requirements prior to proceeding with the installation.

1.139.4 All overflow pipes shall have identification plates indicating the source and location of appliances at their final discharge point.

1.140 Identification of Pipes

1.140.1 All soil, vent, rainwater pipes and pumped mains installed within the Contract shall have identification bands colour coded in accordance with BS 1710.

1.140.2 The colour bands shall be of 75mm minimum width grounded colour bands. The bands shall be self-coloured coded in accordance with BS 1710.

1.140.3 Identification band shall be located adjacent all ceiling or duct access points.

1.140.4 Exposed pipes shall be provided with identification bands at a maximum distances of 5 metres between bands. Adjacent each identification band shall be arrows indicating the direction of flow and stencilled labels describing the service the pipe is serving. The lettering shall be 25mm high.

1.141 Painting

1.141.1 All black steel pipework, unless otherwise specified, together with steel hangers, brackets, supports, gantries, anchors, guides, etc. provided and erected under this contract shall be painted with one coat of zinc chromate paint after erection.

1.141.2 On completion, all exposed piping in the plant and tank rooms, together with brackets, flanges, smoke pipe, boiler doors, etc. shall be painted two further coats of heat resistant paint to approved colours.

1.141.3 All pipes and iron work to be painted shall first be thoroughly cleaned so as to be free of scale, rust, oil, etc. Uninsulated non-ferrous valve bodies shall be thoroughly cleaned and left unpainted.

1.141.4 Galvanised pipework subject to condensation shall be painted with anti-condensation paint, as manufactured by Seculate Ltd or equal and approved.

1.141.5 All welds in steel mains, brackets, etc. throughout shall be wire brushed and the weld given one coat of zinc chromate paint for 250 mm either side of the weld, maximum 1 hour after welding.

1.141.6 Hot and cold pulled sets, etc. to be wire brushed and given one coat of zinc chromate paint.

1.141.7 All plant and equipment, control panels and other special items shall be delivered to site with a factory finish in accordance with this specification to be as the manufacturer's factory finish. All finishes shall be protected once delivered to site in accordance with this Specification.

1.141.8 The Contractor must ensure that work covered by this contract is carefully pre- arranged with the Construction Manager to ensure that damage to finished paintwork does not occur.

1.141.9 All pipework in ducts and in damp situations shall be painted two coats of zinc chromate before any insulation is applied.

1.141.10 Dry riser systems shall be painted with one finish coat of red paint utilising an appropriate primer in accordance with the pipe manufactures.

1.142 Sterilisation of Water Services within Building

1.142.1 The whole of the internal Water Services distribution system shall be flushed out and sterilised to the complete satisfaction of the local Water Authority and the Architect.

1.142.2 These works shall be undertaken and certified by a Specialist Contractor who shall issue a method statement for the Services Engineers approval prior to the commencement of these works.

1.142.3 Where the Local Water Authority does not carry out the sterilisation of new private mains but only of the public mains the Contractor shall include for such sterilisation.

1.142.4 The following procedure shall be adapted:

1.142.5 All visible dirt and debris shall be removed from the cistern. The cistern and distributing pipes shall be filled with clean water and then drained until empty of all water. The cistern shall then be filled with water again and the supply closed. A measured quantity of sodium hypochlorite solution of known strength shall be added to the water in the cistern to give a free residual chlorine concentration of 50mg/L (50p.p.m.) in the water. The cistern shall be left to stand for 1hr. incoming water supply shut off then each draw- off fitting shall be successively opened working progressively away from the cistern. Each tap and draw-off fitting shall be closed when the water discharged begins to smell of chlorine. The cistern shall not be allowed to become empty during this operation; if necessary it shall be refilled and chlorinated as above. The cistern and pipes shall then remain charged for a further 3hrs.

1.142.6 The tap furthest from the cistern shall be opened and the level of free residual chlorine in the water discharged from the tap shall be measured. If the concentration of free residual chlorine is less 30mg/L (30ppm) the disinfecting process shall be repeated.

1.142.7 Finally, the cistern and pipes shall remain charged with chlorinated water for a least 16h, e.g. overnight, and then thoroughly flushed out with clean water until the free residual chlorine concentration at the taps is no greater than that present in the clean water from the water supplier's mains.

1.142.8 Note. Proprietary solutions of sodium hypochlorite should be used in accordance with the manufacturer's instructions having due regard for health and safety.

1.142.9 A graduated container should be used to measure out the volume of solution required for disinfection. This can be calculated from the manufacturer's literature.

1.142.10 Upon completion of the works the Contractor shall issue a test certificate, for inclusion in the Operating and Maintenance Manuals, signed by the Contractors Representative and witnessed by the Services Engineers Representative describing the extent of works, date and method of sterilisation.

1.142.11 Where chlorinated water that has been used to disinfect an installation is to be discharged into a sewer, the authority responsible for that sewer shall be informed.

1.142.12 Where this water is to be discharged into a natural water course or into a drain leading to a natural water course, the authority responsible for land drainage and pollution control shall be informed.

1.142.13 Where any pipework under mains pressure or upstream of any back-syphonage device within the installation is to be disinfected, the water supplier shall be informed sterilisation of water services outside buildings.

1.142.14 Pipework shall be effectively cleaned and disinfected before being taken into use and on each occasion after being opened up for repair or alteration.

1.142.15 The piping shall be disinfected at the same time as the water supplies mains are being disinfected.

1.142.16 At the time of laying, large bore pipes shall be brushed cleaned and sprayed internally with a strong solution of sodium hypochlorite. In the case of small bore pipes a polyurethane foam plug soaked in that solution shall be inserted and passed through the bore.

1.142.17 Note: This may be done by inserting it at a hydrant and washing through to an end hydrant or otherwise open end.

1.142.18 Pipework under pressure, chlorination shall be carried out through a properly installed injection point at the beginning of the pipeline, using a chemical pump, until the measured free residual chlorine at the end of the pipeline is not less than 20mg/L (20 ppm). The chlorinated solution shall be left in the system for not less than 24 hour and then the whole thoroughly flushed out with clean water until free residual chlorine in water at the end of the pipeline cannot be detected at a level above that present in the clean water entering the pipeline from the water supplier's mains.

1.142.19 Where junctions are inserted into an existing pipeline, the junction itself shall be cleaned and disinfected by immersion in a strong solution of sodium hypochlorite before insertion and the new pipeline from the junction treated as previously described.

1.142.20 Every new domestic water service in premises separately occupied as a private dwelling where the service and distributing pipes serve only that dwelling and any extension or modification to such a service shall be thoroughly flushed with fresh water drawn direct from the water suppliers' mains, immediately before being taken into use.

1.143 Sanitary Services Installation

1.143.1 The whole of the sanitary services installation shall comply with BS EN 12056.

1.143.2 The whole of the materials to be used in this contract shall be of the best quality of their respective kinds, and where such exists the material shall conform to the latest British Standard Specification and be acceptable to the Local Authorities. Materials are to be purchased from a manufacturer in accordance with the approved list of manufacturers elsewhere in this specification.

1.143.3 Where British Standards and Code of Practice Publications are cited such as be deemed to refer to the current editions.

1.143.4 All pipework and fittings used in the construction of the various systems described shall be straight, cleanly finished, round in cross section, free from cracks and surface flaws.

1.143.5 All pipework used shall be new and shall arrive on site colour banded to identify different grades.

1.143.6 All pipework stored on site shall at all times be arranged with adequate facilities for prevention of damage or rusting. Pipework shall not be left lying on the ground.

1.143.7 All pipework shall be free from burrs, rust and scale and shall be thoroughly cleaned before installation. All pipework and fittings shall be installed with sufficient and adequate fixings, and with due consideration for expansion, insulation, prevention of rusting or damage to the building fabric or finishes and for appearance and subsequent access.

1.143.8 In occupied spaces, such as offices pipework shall follow the contours of the walls, floors and ceilings where exposed to view. Where two or more pipe runs follow the same routes care shall be taken to ensure that all are parallel to each other and to the building structure where applicable, except for the required allowance for venting, etc.

1.143.9 No joints of any kind shall be made within the thickness of walls, floors or ceilings, unless the indicated design makes this unavoidable.

1.143.10 Due consideration shall be given to the prevention of obstruction in pipes by burrs, surplus welding or other jointing material or other foreign matter.

1.143.11 During the course of the contract all open ends shall be plugged or capped to prevent the ingress of dirt or building materials with purpose made caps plugs or plastic covers. Wood, ray or paper plugs shall not be used.

1.143.12 Failure to comply with this requirement shall give the Architect or Representative the right to order the pipework to be dismantled and cleaned internally for as far as considered necessary such works shall be carried out at the Contractors own expense.

1.143.13 Where pipes pass through walls, floors or ceilings, a sleeve shall be provided as indicated on the drawings of a similar material to the pipe used.

1.143.14 The sleeves shall finish 2mm proud of finishes surfaces. Puddle flanges shall be provided to the pipework where indicated on the drawings or when passing through retaining or tanked walls.

1.143.15 The annular space between pipes and sleeves shall be caulked with an approved fire proof compound.

1.143.16 Cat in pipework where installed in copper shall be wrapped in “Denso Tape” or equal, to prevent corrosion.

1.143.17 All pipes are to be carefully graded to falls as indicated on the drawings or Codes of Practice to facilitate the correct self-cleaning velocities etc., and self-draining in the case of ventilation pipework.

1.143.18 All the installation of the different system shall be carried out in accordance with the requirements and regulations of the Local Authority and in accordance with BS EN 12056.

1.143.19 All pipework shall be installed truly vertical. Pipes shall be weathered through the roof using proprietary materials to give a weatherproof joint with open and provided with a cowl to prevent ingress of foreign material.

1.143.20 Where a pipe of a combustible material passes through a fire break wall, it shall be provided with suitable fire protection where applicable to meet the building regulations. All the pipework shall be adequately fire stopped.

1.143.21 Adequate precautions are to be taken where pipe runs passed under a construction joint. Proprietary flexible joints are to be provided on either side.

1.143.22 Where walk in access ducts are provided the services shall be routed in such a way as to retain the maximum achievable access space.

1.143.23 Access shall be provided at the base of all soil and waste stacks and at each floor where appliances are discharged or provide adequate maintenance in the event of blockage.

1.143.24 Access pipes, rodding eyes and cleaning yes shall be provided at all changes of direction, at the head of horizontal pipes as indicated on the drawings and specification or as otherwise directed or as necessary to enable all pipework to be tested and maintained efficiently.

1.143.25 All access doors or fittings shall be positioned in such a manner that they can be conveniently inspected and cleared at all times, they shall be provided with soft rubber or neoprene gaskets.

1.143.26 Where access points provided to pipework are concealed the shaft or ceiling shall be provided with an appropriate opening.

1.143.27 All traps provided to sanitaryware shall be deep seal tubular two piece, the connection to the waste outlet being made with PTFE tape.

1.143.28 All branch soil and waste pipe fittings shall be of the swept radius type. Offsets in soil stacks shall only be installed where indicated on the drawings.

1.143.29 Trap ventilating pipes shall be provided as indicated on the drawings or as may be required to ensure satisfactory retention of trap seals whether indicated on the drawings or not.

1.143.30 Trap vent pipes are to be connected to the top of the branch soil or waste pipe at a point not nearer than 75mm to the crown of the trap and in such a manner as to be above the hydraulic gradient within the waste pipe when the appliance is discharged. Each vent pipe to be carried up above the flood level of the appliance before running horizontally.

1.143.31 The Contractor shall ensure that all ventilating pipes are self-venting and self-draining.

1.143.32 Ventilating pipes shall rise through the building and connect to an adjacent stack one metre above the flood level of the highest appliance connected to that stack or be discharged independently to atmosphere.

1.143.33 All sanitary appliances shall be trapped within the fitting or by means of a deep seal traps of the appropriate size having a compression union outlet connection.

1.143.34 The diameter of the pipe connections to sanitary fittings shall be as below unless otherwise indicated:

WC	100mm	Urinal	38mm
Basin	2mm	Sink	38mm
Bidet	2mm	Shower	38mm
Bath	38mm	Macerator	50mm

1.143.35 Where it is necessary to introduce a change of direction this shall be undertaken by the Contractor, utilising manufactured fittings or pulled bends, setting round all piers, beams and other projection as necessary, whether such changes of direction in piping are indicated on the drawings or not.

1.143.36 It shall be the Services Contractors responsibility to ascertain the skirting, ceiling heights, sill heights and finished floor levels.

1.143.37 All offsets shall be formed swept in the direction of flow. Where offsets are formed using pipe fittings 45° bends shall be used, branch connections shall be formed utilising a 135° branch and 45° bend swept in the direction of flow.

1.144 Hot and Cold Water Systems Testing and Inspection

1.144.1 When the installations are complete they shall be slowly and carefully charged with water and thoroughly flushed out allowing all air to escape thus avoiding shock or water hammer.

1.144.2 No pipework shall be insulated or buried until the pressure tests have been witnessed and passed by the Contract Administrator.

1.144.3 The Contractor shall provide all labour equipment and materials to carry out this section of the works.

1.144.4 All plugs, caps, tees and drain fittings required to enable the tests to be carried out are to be supplied by the Contractor together with the whole of the testing apparatus and water.

1.144.5 The Contractor shall allow for testing the installations in whole or in part as necessary to facilitate the progress of the works by other trades or to enable the works to be commissioned in sections at no additional cost for testing in part.

1.144.6 Domestic water services systems to be tested at 1.5 x working pressure but not exceeding 9 bar for 30 minutes to the satisfaction of the Water Authority and Contract Administrator.

1.144.7 Boiler and calorifier relief valves shall be removed and these valves tested later. If the rectification of faulty workmanship or materials on sections is likely to involve disturbance to finished structural features, the test pressure shall be twice the working pressure.

1.144.8 Where items of equipment are not capable of withstanding the test pressure, those items shall be isolated by blanking flanges, plugs or temporary pipework make up pieces shall be provided.

1.144.9 Due to the possibility of damage in transit all cisterns, tanks and cylinders shall be re- tested on arrival at site and prior to installation.

1.144.10 All pipework, fittings and appliances shall be offered by the Contractor for inspection by the Contract Administrator for satisfactory support and protection from physical damage, corrosion and frost.

1.144.11 The systems shall also be inspected under working conditions of pressure and flow and each draw-off tap shall be opened and tested for rate of flow.

1.144.12 Any fault discovered during such tests shall be at once remedied by the Contractor at his own expense and the tests re-applied until the Contract Administrator is satisfied that the fault has been remedied and is sound.

1.144.13 All tests shall be witnessed by the Contract Administrator or his representative and shall be to his complete satisfaction.

1.144.14 Prior notification of all site tests shall be given to the Contract Administrator or his representative giving at least 5 working days' notice.

1.144.15 Any existing pipework intended for retention shall satisfy the test criteria above.

1.145 Sterilisation of Water Services within Building

1.145.1 The whole of the internal Water Services distribution system shall be flushed out and sterilised to the complete satisfaction of the local Water Authority and the Contract Administrator.

1.145.2 These works shall be undertaken and certified by a Specialist Contractor who shall issue a method statement for the Contract Administrators approval prior to the commencement of these works.

1.145.3 The following procedure shall be adapted:

1.145.4 All visible dirt and debris shall be removed from the cistern. The cistern and distributing pipes shall be filled with clean water and then drained until empty of all water. The cistern shall then be filled with water again and the supply closed. A measured quantity of sodium hypochlorite solution of known strength shall be added to the water in the cistern to give a free residual chlorine concentration of 50mg/L (50ppm) in the water. The cistern shall be left to stand for 1hr with the incoming water supply shut off then each draw-off fitting shall be successively opened working progressively away from the cistern. Each tap and draw-off fitting shall be closed when the water discharged begins to smell of chlorine.

1.145.5 The cistern shall not be allowed to become empty during this operation; if necessary it shall be refilled and chlorinated as above. The cistern and pipes shall then remain charged for a further 3hrs.

1.145.6 The tap furthest from the cistern shall be opened and the level of free residual chlorine in the water discharged from the tap shall be measured. If the concentration of free residual chlorine is less than 30mg/L (30ppm) the disinfecting process shall be repeated.

1.145.7 Finally, the cistern and pipes shall remain charged with chlorinated water for a least 16h, e.g. overnight, and then thoroughly flushed out with clean water until the free residual chlorine concentration at the taps is no greater than that present in the clean water from the water supplier's mains.

1.145.8 Where junctions are inserted into an existing pipeline, the junction itself shall be cleaned and disinfected by immersion in a strong solution of sodium hypochlorite before insertion and the new pipeline from the junction treated as previously described.

1.145.9 Note. Proprietary solutions of sodium hypochlorite should be used in accordance with the manufacturer's instructions having due regard for health and safety.

1.145.10 A graduated container should be used to measure out the volume of solution required for disinfection. This can be calculated from the manufacturer's literature.

1.145.11 Upon completion of the works the Contractor shall issue a test certificate, for inclusion in the Operating and Maintenance Manuals, signed by the Contractors Representative and witnessed by the Services Engineers Representative describing the extent of works, date and method of sterilisation.

1.145.12 Where chlorinated water that has been used to disinfect an installation is to be discharged into a sewer, the authority responsible for that sewer shall be informed.

1.145.13 Where this water is to be discharged into a natural water course or into a drain leading to a natural water course, the authority responsible for land drainage and pollution control shall be informed.

1.145.14 Where any pipework under mains pressure or upstream of any back-syphonage device within the installation is to be disinfected, the water supplier shall be informed of any sterilisation of the water services outside the buildings.

1.145.15 Pipework shall be effectively cleaned and disinfected before being taken into use and on each occasion after being opened up for repair or alteration.

1.146 Sterilisation of Private Water Mains

1.146.1 The piping shall be disinfected at the same time as the water suppliers' mains are being disinfected.

1.146.2 The whole of the private water mains distribution shall be disinfected to the complete satisfaction of the Local Water Authority and the Contract Administrator.

1.146.3 These works shall be undertaken and certified by a Specialist Contractor who shall issue a method statement for the Contract Administrators approval prior to the commencement of these works.

1.146.4 Where the Local Water Authority does not carry out the sterilisation of new private mains the Contractor shall include for such sterilisation.

1.146.5 At the time of laying, large bore pipes shall be brushed cleaned and sprayed internally with a strong solution of sodium hypochlorite. In the case of small bore pipes a polyurethane foam plug soaked in that solution shall be inserted and passed through the bore.

1.146.6 Note: This may be done by inserting it at a hydrant and washing through to an end hydrant or otherwise open end.

1.146.7 The following procedure shall be adapted.

1.146.8 In pipework under pressure, chlorination shall be carried out through a properly installed injection point at the beginning of the pipeline, using a chemical pump, until the measured free residual chlorine at the end of the pipeline is not less than 20mg/L (20 ppm). The chlorinated solution shall be left in the system for not less than 24 hour and then the whole thoroughly flushed out with clean water until free residual chlorine in water at the end of the pipeline cannot be detected at a level above that present in the clean water entering the pipeline from the water supplier's mains.

1.146.9 Where junctions are inserted into an existing pipeline, the junction itself shall be cleaned and disinfected by immersion in a strong solution of sodium hypochlorite before insertion and the new pipeline from the junction treated as previously described.

1.146.10 Pipework shall be effectively cleaned and disinfected before being taken into use and on each occasion after being opened up for repair or alteration.

1.147 Interim Test Certificates

1.147.1 Interim test certificates for testing during installation shall each include the following:

- Project Name: Service:
- Section Under Test: Nature of Test: Water/Air
- Pressure
- Duration
- Material and Installation in accordance with the Specification? YES/NO Record
  Drawings Accepted by the Contract Administrator YES/NO
- Signatures:
- (For Main Contractors)
- Witness:
- (Contract Administrator)
- Date of Test
- Final Test Certificates

1.147.2 Final test certificates for testing prior to formal acceptance by Architect shall include the following:

1.148 Service:

- Section of Test: Nature of Test: Water/Air Pressure Duration
- Complete set of interim test certificates received by the Contract Administrator
- YES/NO
- Systems Flushed
- YES/NO
- Systems Commissioned YES/NO Record Drawings Received
- YES/NO
- CCTV Survey Completed YES/NO Signatures:
- (For Main Contractor)
- Witness:
- (Contract Administrator)
- Date of Test