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# **STANDARDS OF MATERIALS AND WORKMANSHIP MECHANICAL**

**THE MATERIALS AND WORKMANSHIP DETAILED IN THIS  
SECTION APPLY EVEN IF NOT DETAILED IN THE RELEVANT  
PARTICULAR REQUIREMENTS SECTION**

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## **STANDARDS OF MATERIALS AND WORKMANSHIP – MECHANICAL**

### **1.1 STANDARDS**

This standard specification is to be read in conjunction with the relevant particular specification and preliminaries.

All installation work executed shall be carried out in accordance with the various manufacturers' recommendations and requirements, and shall comply with the following statutory instruments, regulations, recommendations and bodies, as applicable:

- a. British Standards Institute Specifications and/or Codes of Practice and/or British Board of Agreement Certification.
- b. The requirements of Statutory Bodies.
- c. The British Gas Safety Regulations.
- d. The recommendations of the Chartered Institution of Building Services Engineers and Institute of Plumbing.
- e. The recommendations of the local Fire and Emergency Planning Authority.
- f. The Health and Safety Executive.
- g. The Environmental Health Officer and all the COSHH requirements.
- h. Requirements of the local Water Authority and the water regulations.
- i. Requirements of British Gas.
- j. Department of communities and local Government (Building Regulations).
- k. Department of Energy.
- l. N.H.B.R.C and NHBC requirements.
- m. Acts of Parliament.
- n. The Control of Asbestos Regulations 2012 and Approved Codes of Practice and Guidance L127 and L143.
- o. Approved code of practice and guidance L8 2000 the control of legionella bacteria in water systems.

### **1.2 MATERIALS AND WORKMANSHIP (STANDARDS)**

All materials supplied and work carried out shall be the best of their respective kinds and to the approval of the Contract Administrator, who shall be at liberty to order the removal and replacement of any faulty materials or inferior workmanship at no extra costs.

The Contractor shall employ fully skilled specialist craftsmen on the works.

All materials shall be new, and care shall be exercised to ensure that materials shall be kept in that condition, proper storage facilities being used to fulfil this condition.

All materials or parts supplied, or work carried out, shall comply with the British Standards where available. All gas burning appliances shall be approved by the British Gas Corporation.

All domestic services pipework shall be installed to the Standards required by the Local Water Authority.

### **1.3 MANUFACTURERS FINISH**

All equipment supplied and installed shall, on completion, retain, undamaged, the manufacturers finish. All damage shall be made good to the Contract Administrator's complete satisfaction.

## **1.4 ACCESSIBILITY**

For the purposes of this Specification, the word "accessible" shall apply to a space, duct, chase or any other location in which pipework, valves, fittings or plant are to be located. It shall also apply to pipework, valves, fittings or plant, if they will be concealed from view but can be exposed fully by removing purpose made coverings or doors.

It shall also apply to ducts or crawlways into which it is possible to gain access through manholes or trap doors and having gained access there is sufficient space in which to work and dismantle and, if necessary, remove the equipment.

It shall also apply to plantroom equipment, i.e. tank rooms, boiler rooms, machine rooms, pump rooms, etc., or any equipment where access is required to carry out routine maintenance and/or equipment removal in a safe manner.

Any duct, chase or any other location which lacks these facilities shall for the purpose of this Specification be regarded as inaccessible.

## **1.5 PIPEWORK AND FITTINGS**

No joints shall be made in the thickness of walls and floors.

All pipework shall be installed in a neat workmanlike manner, arranged parallel to or at right angles to structural members of the building and shall fit with the work of other services. All pipe drops shall be plumb or parallel with adjacent surfaces.

Piping shall be installed so that there is a minimum clearance of 75 mm between the pipe and the floor and shall be at clip distance from the wall surfaces.

Care shall be taken to prevent dirt entering pipes during installation, open ends of pipes shall be crimped or provided with plastic caps and all valves shall be plugged.

The ends of all pipes are to be reamed to the full bore of the pipe. The removal of any random piece of pipework may be required by the Contract Administrator to ensure that reaming has been carried out. If such examination proves that reaming has not been carried out the Contract Administrator may have such pipework as he considers necessary dismantled and reassembled in a proper and workmanlike manner.

No extra cost will be allowed in respect of any bad workmanship, but if the examination proves to be satisfactory, the Employer will pay for the work.

Branch connections from mains are to be so arranged that expansion and contraction may take place without distortion either to the mains or branches.

Where pipes reduce in diameter, reducing sockets are to be used, due allowance being made for air venting and draining of the installation.

All fittings on the cold water main above and below ground, internal or external, are to have "lead free" solder.

All flux used for jointing is to be applied in a correct and proper manner. Flux shall be water soluble and Water Research Centre approved.

Self cleaning fluxes are not to be used. Evidence of the use of excessive flux will result in the Contract Administrator insisting on the removal of such pipework and its replacement. Any resulting damage from flux corrosion will be deemed the Contractor's responsibility and he will be held liable for any subsequent failures and all resulting damage.

All made and set bends are to have as large a radius as practicable and are to be free of buckling or any form of restriction to the bore. All such bends are to be made with the aid of a bending machine with all appropriate formers and guides.

Screwed pipe fittings are to be of malleable iron to B.S. 143 and 1256:2000 as applicable.

## **1.6 RUN OF PIPEWORK**

The run of pipework is to be arranged in a neat and workmanlike manner. All sets or special fittings are to be included for in:

- a. Flow and return branches to radiators and heat emitters (note flow's into radiators and emitter's to be on same side through the project).
- b. Vertical pipework where walls reduced in thickness.
- c. Pipes that pass over joists, mouldings, casings, etc., beyond the face of the outer or inner walls and partitions.
- d. All necessary setting and bending of pipework including any extra length of pipe and fittings, due to realignment of pipework necessitated by the position of any other services.

Pipework is to be laid to proper graded falls adequately supported with provision for expansion and suitably spaced to accommodate thermal insulation if required.

All pipework installed within floor ducts, screeds of the building structure is to be without joints, except where agreed with the Contract Administrator and installed in such a way as to permit subsequent access for maintenance or removal without disturbing adjacent pipework.

Vertical pipes are to drop parallel to walls, partitions and/or building structure, and flows and returns are to run parallel to each other. Horizontal pipes are to be graded to clear air at vent points or radiators and to drain at low points. Where uninsulated pipes run parallel to one another, a distance of 25 mm is to be allowed between their respective surfaces. All pipework must be fixed and hydraulically tested before the application of paint or thermal insulation.

Pipework is not to be installed closer than 150 mm from any electrical cable, except where cables are encased within P.V.C. mini trunking or at crossover points. In these instances, purpose made fittings shall be installed.

Wherever possible, crossover points are to be avoided, but it is the responsibility of the Contractor to ensure that any crossover points with electrical conduit/cable are adequately insulated one from the other, by the Contractor, to the satisfaction of the Contract Administrator. An air gap of at least 6 mm is to be left between the two surfaces.

In pitched roof spaces no pipes shall be installed within 1500 mm of the eaves.

The Contractor shall ensure that noise and vibration is eliminated from the installation.

Where pipework is in contact with floor or ceiling joists, a felt pad shall be provided. Animal based felt shall not be used.

## **1.7 PIPEWORK**

All open ends of pipe work left during construction shall be temporarily sealed with plugs to prevent foreign matter entering the system.

- a. Steel Pipework for Low Pressure Hot Water Heating Systems:  
Steel pipework for use in low pressure hot water heating systems shall be of heavy gauge quality manufactured in accordance with the provisions of BSEN 10255:2004 and amendments.

Pipework shall be screwed, flanged or welded as detailed in the Sections of the Specification dealing with low pressure hot water.

All bends and tees shall be easy sweep pattern. Elbows, square tees and bushed fittings will not be permitted.

Fittings shall be best quality malleable iron, beaded or banded and easy sweep pattern. Flat seated unions shall not be used, unions shall have bronze conical seats ground in.

Fittings shall be manufactured in accordance with the provisions of B.S. 143:2000 and amendments.

White heart fittings manufactured in accordance with B.S. 1256:2000 and amendments may also be used.

All steel pipework over 50 mm diameter shall be welded unless stated otherwise.

**b. Copper Pipe work for Low Pressure Hot Water Heating:**

Copper pipe work for use in low pressure hot water heating systems shall be manufactured in accordance with E.N. 1057:1996 Part 1, it shall be half hard tempered to R250 and installed by kite mark licensee operating under BSI registered firm scheme in accordance with ISO 9001, fittings shall be to BSEN 1254 and bear the Kite mark.

Fittings shall be manufactured in accordance with E.N. 1254:1998 Parts 1 and 2 and amendments. Copper capillary fittings shall have integral solder ring and be Kite marked.

The use of self cleaning fluxes will not be allowed.

**c. Copper Pipe work for Hot and Cold Water Services:**

Copper pipework for use in hot and cold services shall be manufactured in accordance with E.N. 1057:1996 Part 1, it shall be half hard tempered to R250 and installed by kite mark licensee operating under BSI registered firm scheme in accordance with ISO 9001, fittings shall be to BSEN 1254 and bear the Kite mark.

Fittings shall be manufactured in accordance with E.N. 1254:1998, Parts 1 and 2 and amendments. Copper capillary fittings shall have integral solder ring and be Kite marked.

The use of self cleaning fluxes will not be allowed.

Copper capillary fittings on potable water services (i.e. mains cold water) shall have a lead free integral solder ring and be manufactured by "Yorkshire Imperial Fittings".

**d. Galvanised pipe work for hot and cold water services:**

Galvanised tube shall be heavy grade quality manufactured in accordance with the provisions of BSEN 10255:2004 and amendments. It shall be galvanised after manufacture.

Pipe work shall be screwed or flanged as detailed in the Sections of the Specification dealing with hot and cold water services. All fittings shall be best quality malleable iron galvanised after manufacture, fittings shall be manufactured in accordance with the provisions of BS EN10242: 1995 (ISO49) and amendments.

All bends and tees shall be easy sweep pattern. Elbows, square tees and bushed fittings will not be permitted.

Flat seated unions shall not be used; unions shall have bronze conical seats ground in.

Fittings shall be manufactured in accordance with the provisions of B.S. 143:2000 and amendments.



e. Steel Pipe work for Gas Services:

Steel pipework for internal gas services shall be medium grade quality manufactured in accordance with the provisions of BSEN 10255:2004 and amendments.

Pipework shall be screwed. All fittings shall be best quality malleable iron.

Flat seated unions shall not be used. Unions shall have bronze conical seats ground in. Fittings shall be manufactured in accordance with the provisions of B.S. 143:2000 and amendments. White heart fittings, manufactured in accordance with B.S. 1256:2000 and amendments, may also be used. All bends and tees shall be square pattern. Bushed fittings will not be permitted.

Screwed joints shall be made with Hawk White jointing paste.

External gas services shall be run in heavy quality steel to BSEN10255:2004 and amendments with screwed fittings as above. All external gas piping laid in the earth shall be carried out in yellow polythene tube with electrofusion welded fittings and laid to a minimum depth of 600 mm.

f. Copper Pipe work for Gas Services:

Copper pipe work for use in gas services shall be manufactured in accordance with E.N. 1057:1996 Part 1, it shall be half hard tempered to R250 and installed by kite mark licensee operating under BSI registered firm scheme in accordance with ISO 9001, fittings shall be to BSEN 1254 and bear the Kite mark.

Fittings shall be manufactured in accordance with E.N. 1254:1998 Parts 1 and 2 and amendments. Copper capillary fittings shall have integral solder ring and be Kite marked.

The use of self cleaning fluxes will not be allowed.

g. MDPE pipe work for Gas services Underground

External underground gas mains distribution shall be carried out in polyethylene pipe in accordance with British gas specification GBE/PL2 parts 1 to 6 MDPE yellow, unless shown otherwise on the drawings. Joints shall be made with Electro fusion or butt fusion fittings as Wavin electro fusion (Wavin Plastics Limited Meadowfield Industrial Estate Meadowfield Brandon Co Durham DH7 8RJ) fittings, or equal and approved.

All installation and jointing shall be in accordance with the manufacturers requirements and recommendations.

The pipework shall be laid with a minimum depth to crown of pipe of 750mm (for carriageways and 600mm for footpath and verges) and no deeper than 1350mm. If minimum depth can not be achieved then protection is required in the form of a concrete raft placed above a cushion of gravel fill or similar method.

Trench width should be as narrow as practical and is usually not less than pipe diameter plus 250mm to enable full compaction of the side-fill. In most situations an imported bed and backfill material should be used. Acceptable bedding material includes pea gravel, washed sharp sand or crushed stone smaller than 20mm or sand/gravel mix.

Back fill in carriageway should follow local reinstatement specifications. Heavy mechanical compaction equipment should not be used until the fill over the pipe is at least 300mm.

h. Plastic pipe work for heating, hot and cold water services:

Plastic polybutylene pipework for use on heating, hot and cold services shall be manufactured in accordance with BS 7291 Parts 1 and 2 class S, with standard pipe for use on hot and cold water systems, and barrier pipe used for heating systems.

Fittings shall be integral push-fit mechanism type Hep20 as manufactured by "Hepworth plumbing products".

For mains water above ground distribution can also be carried out co-extruded polyethylene barrier pipe in accordance with BS 6370 MDPE Black.

Joints shall be made with mechanical screwed compression fittings as Protecta-line Acetal (GPS pe pipe systems, St Peter's Road, Huntingdon, Cambs, PE29 7DA), screw compression fittings, or equal and approved. Underground polythene pipework shall be carefully laid in accordance with Local Water Authority Regulations.

i. Copper Pipe work for Buried Water Mains:

Copper pipework for external underground installations up to and including 54 mm shall be manufactured in accordance with the provisions of BSEN 12449:1999 Table Y kite marked, and double wrapped in acid resisting "Denso" tape.

All fittings shall be non-dezincifiable manipulative compression type to BSEN 1254:1998 as "Kuterlite" manufactured by Yorkshire Imperial Metals Ltd or equal and approved.

The pipe work shall be laid on a bed of, and surrounded with free draining coarse sand to give at least 100 mm cover all round. Backfilling shall then commence with a 350 mm depth of selected fine material free from all builders rubble, flints, stones, tree roots, etc., carefully hand packed.

Material shall not be dropped into the trench from a great height. Backfilling shall continue in layers not exceeding 350 mm in depth, well rammed and consolidated. Mechanical ramming shall not be used within 915 mm of the top of the pipe.

j. Polyethylene Pipe work for Buried Water Mains:

Up to and including 63 mm Nominal Bore:

External underground cold water mains distribution shall be carried out in co-extruded polyethylene barrier pipe in accordance with B.S. 6572:1985 MDPE blue with Protecta-line fittings, unless shown otherwise on the drawings. Joints shall be made with mechanical screwed compression fittings as Protecta-line Acetal (GPS pe pipe systems, St Peter's Road, Huntingdon, Cambs, PE29 7DA), screw compression fittings, or equal and approved. Underground polythene pipework shall be carefully laid in accordance with Local Water Authority Regulations.

Above 63 mm Nominal Bore:

External underground cold water mains distribution shall be carried out in co-extruded polyethylene barrier pipe in accordance with BS 6730:1986, MDPE blue, unless shown otherwise on the drawings. Joints shall be made with Electro fusion or butt fusion fittings as Protecta-line (GPS pe pipe systems, St Peter's Road, Huntingdon, Cambs, PE29 7DA), fluid compression fittings, or equal and approved. All installation and jointing shall be in accordance with the manufacturers requirements and recommendations, and those of the Local Water Authority.

The pipework shall be laid on a bed of, and surrounded with, free draining coarse sand to give at least 100 mm cover all round. Backfilling shall then commence with 350 mm depth of selected fine material free from all builders rubble, flints, stones, tree roots, etc., carefully hand packed. Material shall not be dropped into the trench from a great height.

Backfilling shall continue in layers not exceeding 350 mm in depth, well rammed and consolidated.

Mechanical ramming shall not be used within 915 mm of the top of the pipe.

**k. Polyethylene Pipe work for Above ground Mains:**

**Up to and including 63 mm Nominal Bore:**

External underground cold water mains distribution shall be carried out in co-extruded polyethylene barrier pipe in accordance with B.S. 6572:1985 MDPE black with protecta-line fittings, unless shown otherwise on the drawings. Joints shall be made with mechanical screwed compression fittings as Protecta-line Acetal (GPS pe pipe systems, St Peter's Road, Huntingdon, Cambs, PE29 7DA), screw compression fittings, or equal and approved. Underground polythene pipework shall be carefully laid in accordance with Local Water Authority Regulations.

**Above 63 mm Nominal Bore:**

External underground cold water mains distribution shall be carried out in co-extruded polyethylene barrier pipe in accordance with BS 6730:1986, MDPE black, unless shown otherwise on the drawings. Joints shall be made with Electro fusion or butt fusion fittings as Protecta-line (GPS pe pipe systems, St Peter's Road, Huntingdon, Cambs, PE29 7DA), fluid compression fittings, or equal and approved. All installation and jointing shall be in accordance with the manufacturers requirements and recommendations, and those of the Local Water Authority.

The pipework shall be laid on a bed of, and surrounded with, free draining coarse sand to give at least 100 mm cover all round. Backfilling shall then commence with 350 mm depth of selected fine material free from all builders rubble, flints, stones, tree roots, etc., carefully hand packed. Material shall not be dropped into the trench from a great height.

Backfilling shall continue in layers not exceeding 350 mm in depth, well rammed and consolidated.

Mechanical ramming shall not be used within 915 mm of the top of the pipe.

## **1.8 SCREWED PIPE JOINTING**

Where it is specified that the pipework shall be joined together by screwing, the Contractor shall comply with the following instructions:-

**Screwed Joints on Steel Piping:**

Screwed joints shall be made in accordance with the provisions of B.S. 21:1985 and shall be close threaded, pulled up tightly and made with approved jointing compound and long strand hemp.

After joints have been formed all surplus hemp shall be cut away and joint wiped clean.

All reducing sockets shall be eccentric and arranged for drainage and/or venting.

All cuts from standard lengths shall be all burrs and swarf removed and the ends of the pipes shall be trimmed square.

Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.

Where tube is galvanised care shall be taken to ensure that threads are carefully cut so that the number of exposed threads is minimised.

Hemp shall not be used on steam, condensate, gas or oil piping.

## **1.9 FLANGED JOINTS**

All flanges shall be manufactured from mild steel to B.S. 10:1962 and B.S. 4504 of that Specification appropriate to the pressure involved.

Flanges shall be machine faced, trimmed at the edges and spot faced for nuts. Bolt holes shall be drilled and not punched. Flanges on screwed work shall be screwed and subsequently expanded.

Flanges for welding shall be slip-on type. The tube shall finish 3 mm inside the bore and a sealing run shall be applied.

All flanged joints shall be flush and truly aligned and shall employ brass full faced Taylor's corrugated rings coated on both sides with an approved jointing compound. Nuts, bolts and washers shall be black mild steel or galvanised, as appropriate, and all bolts shall be of the correct length. Taylor's rings must be properly aligned; damaged rings shall not be fitted.

## **1.10 WELDED PIPEWORK**

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

### Welded Steel Piping:

Pipework for welding shall be supplied with plain ends, bevelled for butt welding. All welding joints shall be made by Oxyacetylene process and in accordance with B.S. 2640:1982 and amendments, and the "Recommended Practice of Oxy-Acetylene Welds in Mild Steel Pipe Lines" published by the Heating and Ventilating Contractors Association. Welding shall be executed by welders holding a current Certificate of Competency, as required by the welding institute.

All welded tees, branches, reducers, etc., shall have bevelled mitred joints and be finished with a fillet weld of ample dimensions.

Seamless steel butt welding pipe fittings may be used. They shall be manufactured in accordance with B.S. 1965 Parts 1 and 2:1964 and amendments, heavy grade.

Care shall be taken to ensure that welding metal or flux does not project into the bore of the pipe.

All welds shall be of good clean metal free from slag and porosity, of even thickness and contour, well fused with the parent metal, annealed and hammered on completion and finished smooth.

The Contract Administrator reserves the right to have cut for examination up to 2% of all welds made. The Contractor shall remake the joints at no extra charge.

All sets, double sets and springs shall be formed on long lengths of tube with as large a radius as possible and shall be free from distortion.

### Arc Welding:

The Contractor may wish to employ arc welding for the works or parts thereof.

If the Contractor desires to use arc welding he shall:

- a. Notify the Contract Administrator at the time of tender and the Contract Administrator will ascertain whether it is possible for an electricity supply to be made available. In certain circumstances, e.g. where the supply to a premises is subject to a maximum demand tariff it may be grossly inconvenient for the Employer to make a supply available and the Contractor may, rather than bear the cost, prefer to use portable generating equipment.
- b. Obtain the Contract Administrator's permission at the time of tender.
- c. Include for all charges for electric current and provide all cable and separate meters in his Tender.

- d. Include for the provision of any generating equipment and its operation that may be needed.

Operatives employed on arc welding shall hold a current Certificate of Competency as required by the welding institute.

### 1.11 ERECTION OF PIPEWORK

All pipework shall be erected with continuous gradients. The gradient shall be appropriate to the service, and shall be as follows unless otherwise specified on the Drawings.

<b>Service</b>	<b>Gradient</b>
Low pressure heating (mains)	25 mm in 12 m
Low pressure heating (branches)	25 mm in 6 m
Hot water service (mains)	25 mm in 12 m
Cold water	25 mm in 18 m
Hot water service (branches)	25 mm in 6 m

All piping shall be erected to present a neat and orderly appearance arranged parallel to or at right angles to structural members of the building, and shall give maximum headroom, not obstructing windows and doorways, and fitting in with the work of other Contractors. All pipe drops shall be plumb. No joints shall be formed in the thickness of walls, floors or ceilings.

It shall be the responsibility of the Contractor to ascertain the thickness of plaster and other wall finishes, skirting heights, cill heights and floor finishes. Pipework shall generally be set around all piers and columns and shall follow the counter of the building whether so indicated on the drawings or not.

Where visible, changes of direction shall be made with fittings in preference to pulled or made bends, except where these are to accommodate expansion.

Piping shall be erected so that there is 75 mm clear below it to the finished floor level and at least 25 mm to the finished wall face or clip distance as appropriate.

All pipework, valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement.

Unions or flanges shall be provided at valves and equipment so that they can be dismantled, and elsewhere as necessary to facilitate erection and disconnection. Flanges or unions shall be provided on straight horizontal unobstructed runs at not greater than 12 m intervals. Unions may be used for lines up to 50 mm diameter.

The Contractor shall make due allowance during erection for thermal insulation.

Bends, springs and off-sets shall be formed by use of an efficient bending machine or fire sets. Fire sets shall not be employed on galvanised tube. Copper tube may have its bends, springs and off-sets formed with springs.

All changes of direction so formed shall be made with a minimum loss of local wall thickness and the diameter shall be maintained. Crinkled and scored work will be rejected. Cutting and shutting will not be permitted.

## 1.12 PIPE SUPPORTS

All pipe work shall be supported by means of clips, hangers, etc., at the following centres:

<u>Nominal Bore of Steel Pipe (mm)</u>	<u>Interval (metres)</u>	
	<u>Vertical</u>	<u>Horizontal</u>
15	2.4	2.0
20	2.4	2.4
25	3.0	2.7
32	3.0	2.7
40	4.5	3.0
50	4.5	3.4
65	4.5	3.7
80	6.0	3.7
100	6.0	4.1
125	6.0	4.4
150	6.0	4.8
200	6.0	5.1

<u>Nominal Bore of PVC Pipe (mm)</u>	<u>Interval (metres)</u>	
	<u>Vertical</u>	<u>Horizontal</u>
15	1.3	0.7
20	1.4	0.7
25	1.6	0.8
32	1.7	0.9
40	1.9	1.0
50	2.2	1.1
65	2.8	1.4
100	3.1	1.6
150	3.7	1.9

<u>Nominal Bore of MDPE BLK Pipe (mm)</u>	<u>Interval (metres)</u>	
	<u>Vertical</u>	<u>Horizontal</u>
20	0.9	0.5
25	1.2	0.6
32	1.2	0.6
50	1.5	0.8
65	1.6	0.8

<u>Nominal Bore of Copper Pipe (mm)</u>	<u>Interval (metres)</u>	
	<u>Vertical</u>	<u>Horizontal</u>
15	1.8	1.4
22	1.8	1.4
28	2.0	1.7
35	2.0	1.7
42	3.0	2.0
54	3.0	2.0
67	3.6	2.0
76	3.6	2.4
108	3.6	2.7
133	3.6	3.0
159	3.9	3.4

In the event of two or more pipes being carried out by a single support the spacing shall be for the shorter intervals.

Where copper or steel piping is at low level (floor) 15 mm and 22/20 mm diameter shall be supported at 600 mm intervals and all other sizes up to 76/80 mm at 1800 mm centres.

All supports for mild steel pipes and fittings shall be ferrous. Within rooms, all brackets supporting pipework shall be of school board pattern.

Soft pads shall be provided in all cases where there is a possibility of piping running against woodwork or other materials to avoid the possibility of noise after the plant has been set to work. Animal based felts shall not be used.

It shall be the responsibility of the Contractor to ensure that all supports are adequate, firmly and truly fixed, and that they do not promote vibration. The Contractor shall report inadequacies in this respect to the Contract Administrator. Services in the ground shall be erected with care and in such a manner that pipework and fittings shall not be damaged due to movement of the ground. Where pipes pass under roadways carrying vehicles they shall be fitted inside sleeves or conduits.

Where piping is to be supported under concrete, construction inserts for this purpose shall be provided and shall be placed in the formwork before concrete is poured. Inserts shall be of cast iron or mild steel of the type to receive bolts, heads or nuts after installation and shall permit adjustment of the bolt in a horizontal direction.

All light gauge copper pipework is to be supported at a maximum distance of 600 mm between supports with SCH nylon saddles, as manufactured by Arthur Fischer (U.K) Ltd, Type 1216 SCH and 1623 SCH, or equal and approved manufacture. These are to be screwed to the walls, partitions, etc., with brass screws.

Where multiple pipe clips are necessary sufficient screws must be inserted to provide adequate support.

The final fixing shall be to the approval of the Contract Administrator. SCH nylon saddles are not to be used where pipework is insulated. Brass single ring clips/skirting clips shall be used to provide a suitable space to allow the installation of the specified pipe insulation.

Brackets or supports shall be set out so that they do not obstruct the access to valves, flange or other fittings requiring maintenance.

Supports to chilled water pipework shall include for spacer blocks to provide vapour seal continuity with the thermal insulation material.

These blocks shall be either two piece wooden blocks or crocodile segmented wooden or plastic blocks. Pipe fixings/saddles to be fitted to the outside of the blocks.

### **1.13 PIPE SLEEVES**

Where pipes pass through walls, floors, footings and waterproofed membranes, the Contractor shall provide sleeves. Sleeves shall be correctly positioned and built in.

The inside diameter of sleeves shall not be less than 15 mm larger than the outside diameter of the pipe, except where pipes pass through bearing walls or footings where sleeves shall be 100 mm larger than the outside diameter of the pipe and sealed after installation.

Sleeves in bearing walls or footings shall be cast iron pipe.

Sleeves in walls, floors, ceilings and partitions shall be of the same metal as the pipe.

Sleeves of other materials will be permitted provided that they are inert and approved by the Architect.

Sleeves shall terminate flush with the finished surface.



Flashing sleeves shall be provided by the Contractor where pipes pass through waterproofing membranes. Flashing sleeves shall be provided with an integral flange to which a flashing shield can be clamped or welded. The shields shall be in zinc and shall extend not less than 200 mm from the sleeves in all directions. The Contractor shall make the shield into the membrane and shall fill the space between the sleeve and pipe with waterproof material and mastic.

#### **1.14 WALL AND FLOOR PLATES**

Where pipes pass through floors, ceilings and pre-finished partitions, etc., they shall be fitted with chromium plated wall or floor plates. The Contractor shall space his pipes to allow the fitting of full plates where possible, but if cases of overlapping plates occur then both plates shall be cut to give a uniform appearance.

#### **1.15 TESTING PIPEWORK**

All pipework, fittings, plant and equipment shall be tested hydraulically to a pressure equivalent to one and a half times the working pressure or 3.5 bars whichever is the greater. After the pressure is obtained the test rig shall be disconnected and the pressure shall remain constant for two hours. During this period all welds on steel pipe shall be well hammered.

Water services pipes must withstand the working pressure with all draw off taps closed, without showing any leakage, sweating or other defects.

All gas pipework shall be air tested on completion or in sections as may be required during progress of the works, by installer with relevant gas safety certification.

The Contractor is to provide the necessary instruments, materials and attendance for preparing prior to, during and after tests.

The Contractor shall make good any leaks or other defects, re-test and leave the system completely satisfactory.

All tests shall be witnessed by the Contract Administrator or such other persons who shall be nominated to witness the tests. No pipework shall be insulated or concealed until the test has been witnessed and passed.

Test certificates are obligatory and shall be provided for the Contract Administrator signature.

The Contractor shall allow in his tender for testing the installations in whole or in part as necessary to facilitate the progress of works by other trades or to enable the works to be commissioned in sections. No extras shall be allowed.

All test certificates shall be incorporated into the relevant section of the finalised operation and maintenance manual.

With regard to external pipework RBKC will require their representative to inspect prior to excavations being closed. Contractor not to close until signed off. Void closures will be carried out by MEP consultant, contractor's project management team and RBKC representative.

#### **1.16 STORAGE OF PIPEWORK**

All tubes stored on site shall be kept clear of the ground and where possible they shall be stored under cover.

Screwed ends of tubes shall be protected with a socket, half socket or plastic thimble. Tubes must be examined internally before and after cutting and any foreign matter must be removed.



Stocks of tube remaining on site for long periods must be periodically inspected and tube corroded beyond normal "stock rust" condition shall not be used. The Contract Administrator will instruct the Contractor to remove tube in poor condition from the site whether fixed or not and no extra will be allowed in any circumstances whatsoever.

### **1.17 PREVENTION OF DIRT ENTERING PIPE, VALVES, ETC**

The Contractor shall guarantee that all tubes, valves, fittings, etc., are free from corrosion and internal obstruction. Pipework showing signs of corrosion shall not be fitted.

Special care shall be taken to prevent dirt and rubbish entering the open ends of pipes prior to, during and after erection. Wrought iron screwed caps or plugs, or plastic covers only shall be used. Wood, rag or paper plugs shall not be used.

Failure to comply with this instruction shall mean that the Contract Administrator shall have the right to order the pipework to be dismantled for as far as considered necessary and the pipework to be cleaned internally. Such work shall be carried out at no cost to the Employer.

The Contractor is reminded that a valve fitted to the open end of a disconnected pipe is not considered satisfactory to prevent the entry of rubbish. The open end shall be capped, plugged or crimped.

### **1.18 EXPANSION**

Wherever possible, provision for expansion and contraction of piping is made by changes in direction and the Contractor is to take full advantage of this during installation, applying "Cold draw" if necessary. In other cases, adequate expansion loops or expansion fittings shall be provided.

Expansion loops when required shall be formed with welded bends. The loops shall be shop manufactured and annealed after welding. Connections to the mains shall be with flanges. Each leg of the loop shall be pulled cold to approximately 50% of the estimated expansion on each leg. This cold draw shall be pulled by means of long bolts through the flanges. Bolts shall be pulled up diagonally to prevent uneven stressing and after the flanges are tight the bolts shall be replaced one by one with bolts of the correct length.

During the cold draw process the Contract Administrator shall be present to witness the operation. It is the Contractor's responsibility to give the Contract Administrator adequate notice.

### **1.19 ANCHORS AND GUIDES**

Pipe anchors shall consist of heavy steel collars with lugs and bolts for clamping and for attaching to anchor braces or as detailed on the Drawings. Anchor braces shall be installed in the most effective manner to obtain the required bracing. No anchor braces shall be attached in locations where their installation will result in damage to the building construction. Details of anchors shall be submitted to the Contract Administrator for approval before installation.

Guides shall be provided independent of anchors and expansion joints to prevent buckling. They shall be located at 600 mm either side of expansion loops or fittings and at the mid point between fittings and loops.

Where specifically required anchors and guides are noted on the drawings.

## 1.20 VALVES AND COCKS

All valves and cocks for heating, hot water and cold water shall comply with the requirements of the appropriate Water Authority and the Contractor shall include for any testing and stamping which the Authority shall require.

Gas valves and cocks shall comply with the appropriate Gas Authority requirements.

All valves and cocks shall be located in such a position that they can be readily operated for maintenance. No valve or cock shall be installed in such a position that it cannot be removed for repairs.

The Contractor shall at the time of the Tender point out to the Contract Administrator any discrepancy between a manufacturers type or figure number and that scheduled by the Contract Administrator, and which in the Contractor's opinion is incorrect.

Valves and cocks shall be supplied to the following detail unless specified to the contrary in the following sections:

### Heating Circuits and Chilled Water Circuits:

SERVICE	OVENTROP	HATTERSLEY	CRANE	T.A.	HERZ
<b>Isolation:</b>					
50mm and below	107 90	100	D171A	TA85	K-KV
65mm and over	104 80	970	F624	TA36	BF-FLL
<b>Regulation/Commissioning</b>					
<b>Commissioning Valves:</b>					
50mm and below	106 08	CV2432	D931	MD41	4217CS
65mm and over	106 28	CVM 2733 PN16	DM940	MDF4	4218CS
<b>Low Flow:</b>					
50mm and below	106 11 64	1473	D933/D934 (D922)	MD22	-
<b>Medium Flow:</b>					
50mm and below	106 06 34	100M	-	MD03	-
<b>Regulation Values:</b>					
50mm and below	106 01	1432	D920	MD20	4217
65mm and over	106 26	M733DR	DM920	MDF4	4218
<b>Orifice Values:</b>					
50mm and below	106 06	1000	D901	MD01	4000
65mm and over	106 07	M2000 PN16	DM900	MDF0	HV2740

Hot and Cold Water Circuits and Distribution:

SERVICE	OVENTROP	HATTERSLEY	CRANE	T.A.	HERZ
<b><u>Isolation:</u></b>					
50mm and below	104 30	33X	151	TA64	-
65mm and over	104 80	370	F624	TA36	-
Or					
50mm and below	107 95	100C	D171C	TA85C	-
65mm and over	107 90	100	D171A	TA85	-
<b><u>Regulation/Commissioning</u></b>					
<b><u>Commissioning Valves:</u></b>					
50mm and below	106 08	CV2432	D931	MD41	4217DZR + 4000
65mm and over	106 28	CVM 2733 PN16	DM940	MDF4	4218 + 2740
<b><u>Regulation Values:</u></b>					
50mm and below	106 01	1432	D920	MD20	4217DZR
65mm and over	106 26	M733DR	DM920	MDF2	4218
<b><u>Orifice Values:</u></b>					
50mm and below	106 06	1000	D901	MD01	4000
65mm and over	106 07	M2000	DM900	MDF0	HV2740

Hot and Cold Water branches:

Gunmetal screwdown stopcocks to B.S. 1010 with crutch handles. (Easy clean pattern).  
Additionally, a service valve shall be fitted to every float valve or W.W.P's as above.

Failsafe Blending Valves:-

	HERZ	OVENTROP	HORNE
15mm	Hertzshield	130 03	TMV15
22mm	Hertzshield	130 03	TMV120

### Radiator Valves:

Valves on connections to radiators and convectors shall be of the wheelhead or thermostatic type on the flow and lockshield pattern on the return, as detailed later in the Specification.

TYPE	CRANE	OVENTROP	HERZ
Angle:			
W/H	D880	119 00	DR-T-90 or GP
L/S	D881	109 06	RL-I or RL-5
Straight:			
W/H	D890	119 01	DR-T-90 or GP
L/S	D891	109 07	RL-I or RL-5

### Thermostatic Radiator Valves:

Where thermostatic radiator valves are specified they shall have standard bodies, chromium plated and shall be installed in accordance with the manufacturers recommendations, but after heating circulation tests and balancing, during which thermostatic heads shall be removed.

TYPE	CRANE	OVENTROP	DANFOSS	HERZ
Angle	D882CP	118 37	RA - N	TS-90
Straight	-	118 38	-	TS-98V
Heads	-	1018561	RA2000 Range	9230/9430 range

### Convector and Fan Coil Valves:

Valves on connections to convectors or fan coil units shall be straight pattern wheelhead on flow connection and straight pattern lockshield on return connection.

CRANE	OVENTROP	HERZ
D171 Ball Valve	107 90	K-KV
	107 95	-
D171 L/S Ball Valve	107 92	DR-T-90
	107 99	-

### Gas Cocks:

Newman-Milliken Lubricated Plug Cocks, Fig. No. 200M and 201M.

Oventrop: Up to 50mm 301 64

65mm and above 104 81

### Underground Stopcock:

These to be fitted to polythene tube to be Yorkshire Fig. 771 GM.

For pipe work with flanges 65mm and above Crane F52 Cast iron gate valve

### 1.21 VALVE KEYS

The Contractor shall mount on a polished boards fixed in the plant rooms any specialised valve keys necessary for the maintenance and adjustment of the equipment installed.

### 1.22 AUTOMATIC AIR VENTS

Where automatic air vents are shown on the Drawings and elsewhere as necessary they shall be of Charles Winn manufacture or Oventrop Fig. 108 32. In all cases the air vent shall be preceded by a lockshield pattern stop valve and the discharge from the air vent shall be 12 mm copper pipe which shall discharge over a gully, sump or other convenient position which shall be agreed with the contracts administrator.

The float and valve mechanisms shall be suitable for use with hot water.

Oventrop            108 82 03

### 1.23 AIR COCKS AND BOTTLES

Air vents shall be fitted to all high points of the heating and hot water services.

All radiators, convectors and all pipework which requires venting shall be fitted with 6 mm air cocks unless otherwise specified.

Air bottles where shown on the drawings and elsewhere as necessary, are to be formed from:-

- a.     150 mm length of tube of equal bore to the pipe being vented, on pipework up to and including 50 mm diameter.
- b.     50 mm diameter tube of a length equal to 150 mm plus one diameter of the pipe being vented on pipework exceeding 50 mm diameter.

All air bottles shall have a 6 mm pipe welded into the top and taken to low level and fitted with a 6 mm lockshield needle valve as Hattersley Fig. 5N and plugged.

The Contractor shall fit these items so that they are readily accessible.

Open vents shall be vertical or where it is necessary for them to travel horizontally they shall rise continuously.

### 1.24 DRAIN COCKS

Drain cocks shall be fitted on boilers, hot water cylinders and on all low points of the heating, hot and cold water services, and on the 'dead' side of all isolating valves and cocks whether shown on the Drawings or not.

Drain cocks shall be of gunmetal with screwed ends to B.S. 2879:1980.

Hattersley            Fig 371 lock shield pattern or  
Oventrop:            Plantrooms - 103 33  
                              General use - 103 35

They shall be positioned as unobtrusively as possible. If a drain cock must inevitably be positioned where it may prove a danger or nuisance, one elbow shall be fitted so that the drain cock lies parallel to the pipe being drained and hence is protected by it.

For boilers, calorifiers, cylinders and cisterns the following sizes shall be used:-

20 mm diameter for boilers of up to 8 sq. m heating surface and for calorifiers, cylinders, and cisterns up to 900 litres capacity.

25 mm diameter for boilers over 8 sq. m and calorifiers, cylinders and cisterns above 900 litre capacity.

### **1.25 PRESSURE GAUGES**

Pressure gauges shall be provided on boilers, pump sets and elsewhere where specified, or shown on Drawings. Gauges shall be N.A.B.I.C. Fig. No. 62, brass cased, 100 mm diameter. Gauges shall be graduated metres head and in bars and N/m<sup>2</sup> from zero to twice normal working pressure of the system. The normal cold fill pressure shall be indicated by a red pointer. Each gauge shall be provided with a brass siphon tube and lever handled isolating cock.

Where gauges are remotely located they shall be complete with the necessary tubing neatly fixed. Remote gauges shall be grouped and mounted on a black enamelled steel panel with identification labels.

### **1.26 THERMOMETERS**

Thermometers shall be dial pattern, 100 mm dia. and of N.A.B.I.C. manufacture. Each thermometer shall be provided with a pocket and oil filled well. Thermometers shall be fitted in easily readable position inserted into pipe work to a sufficient depth to ensure accurate readings are given. Thermometers shall be provided on boilers and elsewhere where specified, or shown on the Drawings.

All thermometers shall be fixed so that the bulb is properly immersed.

Thermometers shall be graduated in °C from 0°C to 150°C.

### **1.27 BOILER SAFETY VALVE**

Water safety valves of the totally enclosed type shall be fitted on each boiler and calorifier to the sizes as specified by the equipment manufacturer.

The safety valves shall comply with BS EN ISO 4126-1 and shall be of Gunmetal construction and spring loaded with a metal to metal seat. A padlock and key shall be provided to each safety valve.

A full bore drip pipe shall be fitted from the outlet of each safety valve to carry any water discharge clear of the appliance being protected and its insulation. This drip pipe shall terminate with a square cut end 450mm from the floor in a safe, but in an easily visible position preferable over a drain. Discharge pipes shall be copper on copper systems, galvanised on all others.

Each valve shall be stamped to show the actual bore of the valve and shall be arranged so that the valve can be rotated and lifted from its seat during the testing without unlocking and set to blow at a minimum of plus 10% of plus 0.7 bar (whichever is greater) of working pressure. However the set pressure of a safety valve must not exceed the design pressure of the equipment or system being protected.

The safety valves shall be as manufactured by the NABIC Fig 542 for vented systems or Fig 500 for unvented systems.

Each valve shall be tested by the manufacturers and adjusted to the correct load before despatch.

### **1.28 STRAINERS AND TEST POINTS**

#### Strainers:

Pipeline strainers are to be installed in the return pipe work prior to any plant item or control valve etc., on heating and chilled water and secondary hot water services.

Strainers are to be type Y strainers as:

Crane                      D297 up to 2" Brass      or      FM276 over 2" cast iron

Strainers located in Glycol filled system shall be suitable for operation with Glycol solution and operating at sub-zero temperatures.

#### Test Points:

Test points shall be fitted on the suction and delivery side of each pump and where indicated on the drawings. These shall be self-sealing ethylene propylene rubber test points as manufacturer by Test Plugs Ltd.

The contractor shall allow for supplying upon completion to one site, one temperature and one pressure test gauge to be handed over to the client on completion of works, also available from Test Plugs Ltd.

### **1.29 WATER REGULATIONS**

The complete installation is to comply in all respects with the Water Supply (Water Fittings) Regulations 1999.

It is the Contractor's responsibility to ensure that all work is carried out on water pipe work etc., is in compliance with the "approved Plumber Scheme" and contractor must provide a "Certificate of Compliance" to the water supply authority upon completion of each appropriate section of work.

Should the Contractor have the work carried out by an "unapproved plumber", and then the Contractor must submit full details (i.e. drawings, material specification, method statement etc.) to the water company at least 10 days prior to commencement of work. The Contractor must submit the details to, the local Water Authority for the area.

### **1.30 LEGIONELLA CONTROL**

The complete installation is to comply in all respects with the Health and safety commissions, "Approved code of practice and guidance on the control of legionella bacteria in water systems L8 2000".

It is the Contractor's responsibility to ensure that all persons carrying out work on water system etc., are fully aware of these requirement and that all necessary works, testing, commissioning, identification and assessment of risks are carried out.

### **1.31 SUPPORTING STRUCTURES AND BRACKETS**

The Contractor shall supply, fabricate and fix all steel structures and brackets required for the support of plant, equipment and services. All such structures are to be constructed of rolled steel sections or similar, of adequate cross section and strength, bolted or welded together and painted two coats of red oxide primer. The Contractor shall provide for approval details of the design of all such structures.

Structures shall, wherever possible, be entirely self-supporting and suitable for bolting to the floor of the building.

Welding or bolting of supports to structural steelwork will not be permitted unless authorised by the Contract Administrator in writing.

### **1.32 SPARES AND TOOLS**

The Contractor shall mount on a polished hardwood board fixed in the plant room any specialised tools necessary for the maintenance and adjustment of the equipment installed.

Provide all necessary spares for motors (belts etc.), ductwork system (Filters etc.) and all major items of plant etc.

### **1.33 GUARDS TO PROTECT PLANT**

All wire guards, handrails and other approved types of guards or gates necessary to protect any of the plant or equipment in accordance with the requirements of the Health and Safety Executive shall be provided by the Contractor.

### **1.34 LUBRICATION**

All bearings, glands and other items of plant and equipment shall be charged with the correct grade of oil/grease as recommended by the manufacturers.

### **1.35 PREVENTION OF NOISE AND VIBRATION**

The Contractor shall take every precaution needed to ensure that noise and vibration are eliminated from the installations. He shall erect piping, ductwork, fans, plant and machinery so that the assembled plants will be suitable for silent operation under the conditions in which they operate.

He shall at the time of tendering draw to the Contract Administrator attention anything which, in his opinion, will cause the system to operate other than silently.

It is the Contractor's responsibility to ensure that the sound level from installed plant is within the design sound levels produced by the manufacturer which shall be submitted to the Contract Administrator prior to ordering.

All running plant shall be provided with efficient anti-vibration mountings.

### **1.36 INCOMING WATER MAINS**

Unless specified to the contrary, the Contractor will commence from the consumers side of the main valves supplied by the Local Water Authority.

### **1.37 CISTERNS AND TANKS**

All tanks are to be either:

One piece or sectional GRP plastic complete with purpose made thermal insulation, or Galvanised where installed into existing system that has existing galvanised services pipe work, with separate insulation added after installation.

Water tanks supports are to be installed to requirements of the water regulation schedule 2, section 7, and paragraph 16.



Above all supports are to be as required by the manufacturer.

All tanks are to be fitted with overflow and/or warning pipe work, as required by the Water Regulations and are to terminate outside the building, all as detailed in Water Regulations Schedule 2 Section 7 paragraph 16.

All tanks are to be fitted with potable water kits as Water Regulations Schedule 2, Section 7 paragraph 16 consisting of:

- a. Effective adjustable valve capable of shutting off the inflow of water.
- b. Service valve on water inlet pipe.
- c. Service valve on all outlet pipes.
- d. Overflow pipe (warning) which excludes insects.
- e. Cover to exclude light and insects, with manhole and ladder as appropriate.
- f. Thermal insulation to minimise freezing and undue warming of water.
- g. Installed as to minimise risk of contamination of stored water, appropriately sized and connections positioned so as to allow free circulation and prevent areas of stagnant water.

All pipe work, within the tank room and where subject to frost damage shall be insulated.

The insulation, in general, on pipe work shall comply with Water Regulations/Bylaws, Schedule 2 Section 3 paragraph 4, the relevant British Standards, Part L of the Building Regulations and section 1.42 of this specification, however the minimum thickness used within dwellings shall be 13 mm.

The provision for safe access to the tanks is given within the following publications that should be referred to for their information.

- a. Design And Maintenance Guide 08, Space Requirements For Plant Access, Operation And Maintenance, Defence Works Functional Standard, Ministry Of Defence.
- b. Building Regulations Approved Document F, section 2.15 to 2.17.

### **1.38 OVERFLOW AND OTHER WARNING PIPES**

Overflow and warning pipes shall be fitted so that they discharge in obvious positions.

Materials shall be mild steel galvanised or copper depending on the plant to which they are fixed. Fittings shall be as appropriate.

Overflows shall be fitted with a continuous fall.

All compliant with the relevant sections of the Water Regulations.

### **1.39 PAINTING GALVANISED TANKS**

The Contractor shall paint in its entirety galvanised cold water storage cisterns including all ties and stays with three coats of a suitable bitumen based paint. The manufacturers instructions covering the application of the paint and preparation of surfaces shall be closely followed.

### **1.40 PREPARATION FOR PAINTING, PAINTING, CLEANING THE WORKS ON COMPLETION**

At the completion of the works all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves, fittings, etc., shall be cleaned of all grease, dirt, metal cuttings, sludge, etc., which may have accumulated. Any discolouration or other damage to parts of the building or its finish or

furnishing due to the failure of the Contractor to properly clean the equipment or piping system shall be repaired by the Contractor without additional cost to the Employer.

The Contractor shall wire brush all black steel pipe work and exposed pipe threads and apply two coats of red oxide paint as the pipe work is installed.

All gas pipe work to be final painted with two coats gloss (yellow ochre) to B.S. colour 08ES1.

#### **1.41 THERMAL INSULATION**

##### Pipework:

All water services pipe work shall be insulated where installed in unheated spaces or underground ducts, voids, ducts or ceilings, etc., or where not forming useful heating surfaces, or where condensation is likely to occur or where subject to frost damage as follows:

All heating, hot or cold water pipe work, cold feeds and vents, etc., within voids, ceilings, casings shall be insulated with fibreglass rigid sections with canvas and bands (at not more than 600 mm intervals) and where exposed to water penetration be painted with two coats P.V.A. emulsion.

Pipe work shall be erected with proper clearance between pipes to allow for the application of insulation. No two pipes shall be lagged together unless prior approval.

Particular attention shall be paid to the appearance of the insulation with respect of joints, bends, uniformity of thickness, finish, irregularities in appearance etc., and any work, which is sub-standard, shall be removed and reinstated at the contractor's expense.

Identification bands/colour coding and direction arrows, shall be provided on all services, heating, hot and cold water pipe work in ducts, voids or ceilings to B.S. 1710:1984.

All heating, hot and cold pipe work within plant rooms/boiler rooms shall be insulated with fibreglass rigid section, scrim covered, pasted and secured. The finish to all services shall be minimum 0.35 mm thick Isofix P.V.C. covering complete with aluminium end caps at brackets and valves, with preformed bends. All joints to be taped with matching grey self adhesive tape with joints concealed from view as far as possible.

All valves, non return valves, strainers, etc., within plant rooms and where exposed outside shall be insulated with removable "muff" covers.

All heating and hot water pipe work buried in floor screeds shall be coated with two layers Denso P.P.S. tape.

All mains cold water pipe work exposed in rooms shall be insulated complete with all necessary protection against condensation.

Where pipe work runs external to the building fabric it shall be insulated with class O Armaflex by Armstrong Industries in accordance with the manufacturers instructions and wrapped in polyisobutylene (PIB) weatherproof external finish sheeting. The PIB sheeting shall be glued/welded as necessary and where the pipework enters the building, the sheeting shall be splayed and adhered to the building surface to form a protected shroud around the pipework entrance.

Pipe work insulation thickness physical characteristics and definitions shall be in accordance with B.S. 5422:2001.

For domestic heating systems Armaflex class O preformed sectional insulation can be used, with all joints sealed with adhesive, installed in accordance with manufacturers recommendations and to the thickness detailed in BS5422:2001 and part L of the Building Regulations.

All hot water cylinders, cold water and feed tanks where not pre-insulated shall be insulated with fibreglass rigid slabs/foil faced wired on as appropriate minimum 75 mm thick.

#### Ductwork:

The Contractor shall supply and install thermal insulation to all ducts as described herein.

All distribution ductwork carrying air at a temperature higher or lower than the design room temperatures ( $\pm 2^{\circ}\text{C}$ ) to prevent duct heat loss, duct heat gain, condensation, etc., shall be thermally insulated. All ductwork (supply and extract) exposed externally shall be insulated.

Kitchen systems shall be insulated to the requirements of HVCA standard DW 172.

Ducts in plantrooms and all recirculation systems - Fibreglass slab foiled backed min 25mm thick.

Ductwork in ceilings, voids, etc. - Fibreglass quilt foiled backed min 25mm thick.

Ductwork exposed externally - Foil faced phenolic foam glued to duct with reinforced polyisobutylene outer finish, glued to phenolic foam min 25mm thick.

#### Refrigeration Pipework:

Thermal insulation shall be applied to all condensate pipe work and all internal hot gas pipe work as follows:

The internal Hot gas, condensate and external condensate pipe work shall be insulated with "ARMAFLEX" Type '0' preformed sectional insulation with all joints sealed with adhesive, installed in accordance with manufacturers recommendations, making sure that end joints are puckered on application to allow for the contraction characteristics of the material. All bends, tees, etc., to have oversize sections filled to ensure a continual vapour barrier. External valves shall be fitted with site made fitting covers in accordance with manufacturers template.

The suction line from the evaporator to the compressor shall be insulated with a material having a thermal conductivity of not less than  $0.04 \text{ W/m } ^{\circ}\text{C}$  and at least 19 mm thick. A vapour barrier shall protect this insulation, which shall not be broken between joints of sectional material or at discontinuities at valves or brackets.

External insulation shall be painted with reflective paint.

**TENDERERS TO NOTE THAT THE FOLLOWING SUPPLIERS ARE NOT TO BE USED**  
Kingspan and Cellotex

### **1.42 LABELS AND IDENTIFICATION**

#### Pipework:

All valves shall be labelled in accordance with a Schedule, which shall correspond to the "asfitted" drawings. The labels shall be of traffolyte sandwich, black letters and figures, on white ground. The labels shall consist of discs attached by chains or wire loops. Each label shall indicate the type of service (e.g. Heating) and a number, which shall agree with a Schedule.

All plant, motor starters and isolators shall be labelled with labels of sandwich "traffolyte" with white lettering on black background. The labels are to be screwed to the fronts of starters and isolators and permanently attached to plant or nearest adjacent wall, etc., and shall indicate the service, number, item, etc.

Each fan, boiler, pump, etc., shall bear a metal label giving the makers name, date of manufacture and serial number, test and working pressures, duty, power, phasing, number of cycles per second, speeds, B.S. number, etc., as appropriate to the item of plant so that it may be identified at a later date with ease.

At times it is difficult to have permanent labels available for plant handover and at such times the Contractor shall provide free of charge temporary "tie on" labels so that all valves and equipment are identifiable.

All uninsulated pipe work, except that visible in offices, habitable rooms, offices, public spaces, corridors, etc., shall bear identification bands and direction arrows similar to those used on insulated pipe work, to BS1710:1984.

#### Ductwork:

This item is based on the Heating and Ventilating Contractors Association Specification DW/144 Identification of Ductwork.

This Specification applies to the identification with colours and description of ducts for ventilation, air conditioning and simple exhaust systems.

This Specification provides for the identification of the air conveyed, the direction of flow, the destination of the air and/or the plant where the air was treated.

### **1.43 CONTROLS**

The H.V.A.C. system installation and controls wiring is to comply with all relevant statutory authorities and in accordance with the requirements of CIBSE Guide H: Building Control System.

Generally the operation of the plant shall be automatic but due to the nature of buildings usage periods an override and extension will be required.

Prior to manufacture and installation of any controls system, schematic wiring and panel drawings are to be provided for approval of the Contract Administrator.

#### Controls Panels – General Standards

This section of the Specification covers the manufacture, supply, installation, test and complete commissioning of the control panels.

The panel main isolator and power distribution system to sub fused circuits shall be suitable for connection to either a 240V 1-phase 50 Hz supply or a 415V 3-phase 50Hz, 4 wire for earth neutral supply, with suitable fault rating, dependant on size and loading of the panel.

Sub-fused components within the panel shall be fault rated in accordance with the circuit.

Plant items shall be interlocked for safe and logical operation (e.g.: pumps run before boilers enabled) delays between loads on start up shall be incorporated where necessary.

Standards – The control panel shall comply with the following standards:

- a. 1) Part P of the building regulations:
- b. 2) Current IEE Regulations with current amendments.
- c. 3) BS 5488 specification for factory built assemblies of Switchgear and Control Gear for voltages up to and including 1000V AC and 1200V DC.

Other standards are referred to for particular items in their relevant sections.

Construction – The panels to be constructed in two sections mains and controls. Cubicle sizes shall be such as to allow adequate space for access to all components within the cubicle, for maintenance purposes.

All starters shall have manual/off/auto switches, Run and Fault lamps, control circuit fuse and power supply fuses. All duplicate items shall be duty/standby via a selector switch with auto change over on trip unless specified elsewhere.

Note: All lamps and switches on the doors to be of low voltage.

Controls sections shall be fitted with an internal isolator with suitable warning labels on the section door. Where control circuits are powered from individual cubicles or sections at low voltage, isolating terminals shall be provided together with suitable warning labels.

Doors shall be a minimum of 2mm thick and shall be folded in the form of a rigid tray, stiffened internally if required, purpose made to the dimensions of the doors where they are installed. Doors shall be braced for the fitting of controllers and indicators.

Recessed sealing gaskets shall be fitted to all doors and cover plates to give dust protective joints at all edges.

Hinges shall be provided to enable the removal of all doors if required. Doors are to be capable of opening through a radius greater than 90° and a restraining mechanism shall be provided to prevent any door opening beyond 120°.

All doors shall be provided with locking type door handles using one common key for all locks on any given project.

All panels shall conform to BSEN 60947:1992, degree of protection IP 54.

Unless otherwise specified, control panels are constructed for front access; allowing all equipment to be removable from the front of the panel, and all maintenance to be carried out from the front of the panel. Fixing screws through the outer shell must be kept to a minimum. Where unavoidable, mushroom or counter sunk head screws shall be used with a chromium plate finish; except for labels, where plastic rivets the same colour as the label background may be used.

All live parts accessible to inadvertent contact when a cubicle door is open shall be shrouded to comply with the Health and Safety at Work Act. Where live equipment cannot be isolated then it should be covered with a Perspex shield carrying a suitable warning label.

The panel shall have a minimum 1.2M clearance in front for maintenance access.

All components shall be mounted on the equipment mounting/back plates; mounting from the sides, bottom or top of the panel shell shall not be allowed. Components shall preferably be DIN rail mounted. Space shall be allowed on the back plates for a minimum of 10% of all items for future use, and a minimum of 10% spare cubicles, preferably located at low level.

Panel construction shall be such that adequate ventilation shall be provided for the internal heat dissipation and in no circumstances shall the internal temperature rise above 40°C. Should louvred sections and/or mechanical ventilation be required they shall be provided.

A rigid document pocket for wiring diagrams shall be fixed inside the control panel or on the back of the new panel door.

Panel Finish – A high standard of finish is required for the control panel doors and covers, the paint is to be applied to a dry rust and grease free metal. The steel may be electro zinc plated or standard mild steel but either must have a minimum of an etch coat, 2 priming coats, an undercoat and 2 finishing coats. The undercoat and finishing coats shall be stove enamelled and the panel shall be rubbed down between coats of paint as required.

A small tin of finishing coat paint shall be supplied for each control panel, colour to be as advised by the original manufacturer according to his records.

Paint finishes to the new doors/covers shall be full gloss stove enamel to BS 4800 colours. Final colour to be approved by Contracts Administrator.

The interiors of the panels shall be wiped clean only. The internal backplates shall be painted gloss white.

Earthing – At one end of the panel the bar shall be fixed to a threaded brass stud which is to be fixed through the panel with nuts and washers to receive the main earth connection.

The earth bar shall have a low impedance and have a current rating which matches the main isolator and shall be jointed at panel sections in an approved manner.

Each item of equipment within the control panel shall be separately earthed to its associated cable.

Earth conductivity by means of door hinges shall not be permitted.

Wiring and Termination – When screened cable is required the screen shall only be earthed at the controller end, not at the sensor. If the controller is mounted in a panel the screen must continue through the panel direct to the controller.

Where M.I.C.C. is used the outer metal sheath can be earth at the panel gland. The wiring inside the panel must be continued in screened cable with the screen earthed at the controller end only. The junction between the M.I.C.C. cable and the screened cable inside the panel should be made as close to the M.I.C.C. gland as possible, the screen of the cable inside the panel must not be earthed at that junction, but should shroud the conductors as close to the junction as possible.

Control and power wiring shall be kept separate as far as practically possible. All internal wiring shall be securely fixed to the enclosures and shall not impede the opening and closing of doors or removal of components. Where possible 'crimp' type connections shall be used.

Control wiring shall be run in plastic trunking where possible. The cable shall not occupy more than 50% of the trunking volume.

Control wiring shall be neatly arranged and cleated. Cleats are to be fixed to the switchboard structure at sufficient intervals to avoid cable sag. Adequate cable loops must be allowed to accessories on doors to avoid cable stretch.

Bunching of cables into large looms shall not be accepted. The maximum number of control cables in any one group shall not exceed 25 conductors. Conductors for heavy loads shall be routed to ensure adequate cooling and shall be separated from control wiring. All unfused cables between bus bars, isolators or fuses shall be routed separately as individual looms.

Extra low voltage cables shall be ribbon cable rated at 300V AC.

Mains cables shall have 600V grade copper conductors, PVC insulated, colour coded as follows:

FUNCTION	ALPHANUMERIC	COLOUR
Protective Conductors		Green and Yellow
Functional earthing conductor		Cream
<b>a.c. power circuit <sup>(1)</sup></b>		
Phase of single-phase circuit	L	Brown
Neutral of single or three-phased circuit	N	Blue
Phase 1 of three-phase a.c. circuit	L1	Brown
Phase 2 of three-phase a.c. circuit	L2	Black
Phase 3 of three-phase a.c. circuit	L3	Grey
<b>Two-wire unearthed d.c. power circuit</b>		
Positive of two-wire circuit	L+	Brown
Negative of two-wire circuit	L-	Grey
<b>Two-wire earthed d.c. power circuit</b>		
Positive (of negative earthed) circuit	L+	Brown
Negative (of negative earthed) circuit <sup>(2)</sup>	M	Blue
Positive (of positive earthed) circuit <sup>(2)</sup>	M	Blue
Negative (of positive earthed) circuit	L-	Grey
<b>Three-wired d.c. power circuit</b>		
Outer positive of two-wire circuit derived from three-wire circuit	L+	Brown
Outer negative of two-wire circuit derived from three-wire circuit	L-	Grey
Positive of three-wire circuit	L+	Brown
Mid-wire of three-wire circuit <sup>(2)(3)</sup>	M	Blue
Negative of three-wire circuit	L-	Grey
<b>Control circuits, ELV and other applications</b>		
Phase conductor	L	Brown, Black, Red, Orange, Yellow, Violet, Grey, White, Pink or Turquoise
Neutral or mid-wire <sup>(4)</sup>	N	Blue
(1) Power circuits include lighting circuits.		
(2) M identified either the mid-wire of a three-wire d.c. circuit, or the earthed conductor of a two-wire earthed d.c. circuit.		
(3) Only the middle wire of three-wire circuits may be earthed.		
(4) An earthed PELV conductor is blue.		

1mm<sup>2</sup> flexible will be the minimum permissible cable size for mains control circuits.

0.5mm<sup>2</sup> flexible shall be the minimum permissible cable size for low current control circuits of 24V only or ribbon cable can be used rated as above.

All internal wiring shall be permanently identified by means of numbered ferrules. These numbers shall be shown on the schematic wiring diagrams where these are used for point to point wiring.



Co-axial or twisted pair cable shall be specified on schematic wiring diagrams. Screens shall be earthed as detailed elsewhere.

Terminals for external control wiring shall be of the isolating type to allow for disconnection of control circuits for commissioning and maintenance.

Terminals shall be of the cadmium plated stud type of a minimum of M5, for accommodating claw or clamp type washers with suitable cable lugs. Terminals shall be permanently labelled with circuit references using cable and core numbering procedures approved by the engineer, and an insulating barrier shall be provided between connections. A maximum of two connections only shall be made per terminal.

Main cable terminations shall be of the 'two stud' type for accommodating crimped cable lugs. All terminations shall have clearance holes. Cable lugs, fully threaded bolts, plain and shake proof washers and nuts shall be provided to sit the cable. Cable tails shall be supported within the equipment at internals not exceeding 450mm. Supports shall be non-metallic and be attached by mechanical means.

Isolators – Isolators and switch fuses shall conform to BSEN 60947:1992.

Panels shall be provided with main incoming unfused isolators (except where notified otherwise) with sufficient auxiliary contacts to enable all live connections entering the panel to be isolated. Where necessary shrouded isolating relays shall be used together with isolating link type terminals. Control and interlock circuits shall preferably be powered at the control panel with local plant isolation via auxiliary contacts of the plant isolators.

All isolators shall be door interlocked on opening sections of cubicles and shall have the facility for locking in the 'OFF' positions, except where internal isolators are specified for control sections.

For 3-phase 34-wire supplies a neutral link of the same rating as the main conductor shall be located adjacent to the incoming cable connections. For single phase supplies the neutral link shall have a rating equal to that of the line conductor. An efficient earth terminal suitably labelled shall also be located adjacent to the incoming cable terminations.

All isolators shall be rated for fault current make. Main panel and known resistive load isolators shall be rated for installed full load current break. Starter isolators shall be rated for motor start current break.

All connection's that are live, with the isolator, in the open position, shall be fully shrouded by an insulated cover and identified by a 415V or 240V danger label as appropriate.

Fuses – Power fuses shall be provided for each starter and contactor and these shall comply with BS 88:2007.

A detailed fuse chart shall be provided and fitted within each panel.

A spare set of fuses containing 10% of the total number of each size of fuse used with a minimum of 2 for each size, shall be fixed inside the panel with suitable clips adjacent to the fuse chart.

Starters – Starters for fan and centrifugal pump motors of up to and including 7.5kW shall be direct on line, above 7.5kW and up to and including 55kW they shall be open transition automatic star-delta, above 55kW they shall be auto-transformer.

Overloads shall be hand reset, and shall have at least single pole changeover contacts.

Direct on line starters shall comply with BSEN 60947:1992 and shall be rated for intermittent duty class 0.3.

Automatic star-delta starters shall comply with BSEN 60947:1992 and be rated for intermittent duty class 0.3. They shall have changeover timers adjustable from one to 30 seconds (subject to fan or



pump characteristics). If the overload relays are connected for phase current, their scales shall be marked to show whether they are indicating phase current or line current.

Electrical and mechanical interlocks shall prevent both star and delta contacts being closed at the same time.

All starters and contactors shall have auxiliary contacts suitable for remote monitoring of run indication. All starters/pair of starters and contactors shall be suitable for remote starting and stopping of plant via a Building Management System (BMS).

Contactors – All contactors shall comply with BS 5424. Unless otherwise specified contactors shall be of the same manufacture as the starters and be fully enclosed.

Relays – Relays shall be of the plug in changeover type.

Labels – Labels shall be supplied for all instruments and components mounted on the front of the control panel. Where a group of indication lights and control switches are associated with one item of plant, a common label shall be used which should describe the components of the group.

Within the panel adequate labelling shall be provided for all fuses, relays, starters and control equipment. Such labelling shall correspond in detail with the panel wiring diagram.

Warning labels shall be provided giving notice of any live low voltage circuits existing when doors are open or when cover plates are removed. Suitable labels shall be fitted identifying circuits requiring isolation by link type terminals.

Labels shall be engraved on traffolyte or similar laminate; but as an alternative for internal labels. Plastic trunking lids may be engraved, in which case the trunking lids must be identified with respect to location.

Labels shall normally have black lettering on a white background, but safety labels shall be to BS 5378.

All labels shall be fixed either with mushroom head screws with a chromium plate finish, or plastic rivets the same colour as the label background. Adhesives shall not be used on panel fascia other than of maintenance references.

Ammeters – All ammeters shall be to BS 89 and shall be provided to replace existing only.

The current passed through an ammeter should not exceed 20 amps inductive or resistive. Above this rating current transformers must be used. Blade terminals are preferred to accept insulated plug-on connectors or recessed screwed connections to prevent inadvertent contact. Ammeters for inductive loads such as motors shall have an extended compressed scale greater than the value of the starting current.

Ammeters must be selected so that the measured value falls within 20-80% of full scale. No circuit wiring from the L2 or L3 phases will be permitted on the panel door.

Indicator lamps – Unless otherwise specified indicator lamps shall be of the low voltage LED cluster type.

RED:	Essential equipment stopped by action of a protection device.
YELLOW:	Temperature, pressure, humidity etc. Outside normal working limits.
GREEN:	Machine started/running in normal condition.
WHITE:	Panel live/other non defined uses.

Switches – All switches shall be rotary type and unless otherwise specified shall be break before make.

In general, switches shall not be capable of continuous rotation; but this may be overridden for functions such as sequence selection or, in the case of ammeters, phase selection.

Where 'MANUAL/OFF/AUTO' switches are provided, the 'MANUAL' position shall override all interlocks except those relating to plant or life safety.

Where interlocks from fireman's switches or fire relays are provided, these interlocks shall override the 'MANUAL' and 'AUTO' positions of 'MANUAL/OFF/AUTO' switches.

Instrumentation and Controls – A separate panel section shall be provided for mentation instrumentation and controls.

All panel fascia items, and adjustable and/or indicating controllers whether fascia or internally mounted, shall wherever possible, be mounted at a height between 1000mm and 1750mm from finished floor level.

Drawings – Two copies of the panel layout and schematic wiring diagrams shall be submitted for approval by the Contract Administrator.

The panel layout drawings shall be adequately dimensioned, and shall show the arrangement of all components mounted on the face of the panel.

The wiring diagrams shall show the electrical ratings and full load currents of all motors and other equipment supplied from the panel, the ranges of all starter overloads, and all fuse ratings. All wiring and terminals shall be numbered. References and terminal numbers of all external equipment connected to the panel shall be shown although it is accepted that this information may not be available at the time of approval.

When the drawings have been approved, the manufacturer shall issue two copies of all approval drawings.

When the panel doors/interiors have been built and delivered to site, two copies of the as manufactured wiring diagrams shall be supplied in a rigid document pocket permanently fixed behind a non interlocked panel door, e.g.: control section.

Works inspection and testing of all panels shall be carried out testing on site in the presence of the Contract Administrator.

The paintwork shall be examined for any scratches or blemishes.

The wiring shall be checked for loose connections, and compliance with the wiring diagrams.

The insulation resistance in each case shall not be less than 20 megohms.

- |                   |                     |
|-------------------|---------------------|
| 1) Phase to phase | 2) Phase to neutral |
| 3) Phase to earth | 4) Neutral to earth |

A test certificate for each panel shall be issued by the manufacturer.

Fireman's Switch – the override functions are as follows:

Normal/On/Off/Extract only and shall be tested for correct operation.

#### **1.44 DRY RISER**

The dry riser installation shall be as indicated on the drawings.

This shall be to the complete satisfaction of the contracts administrator, the Local Fire and Civil Defence Authority (L.F.C.D.A) and the building control team, who will witness test consisting as a minimum, water flow through system discharge at top outlet to flush out debris, then fill with water and test to 10 bar (measured at inlet), held for 15 minutes, with no leaks allowed.

Inlet and landing valves are to be provided, inlet to consist of a twin inlet breeching piece with outlets comprising of a landing valve, both complete with glass wired door cabinet to suit.

A landing valve outlet is to be provided at each floor level including the roof.

The dry riser and associated landing valves are usually located in the main lift lobby area, and lowest point of the system is usually the breeching inlet point and this shall be complete with a drain off cock. However, if the inlet is not the lowest point of the system, then a second drain cock is required at the actual lowest point with label indicating its function.

The entire system shall conform to BS 5306 (part 1) and BS 5041 (part 1 – 5 inclusive).

Dry riser system is to be exponentially bonded.

No elbows are to be used, must be full radius bends only.

Pipe work shall be installed using galvanised mild steel tubing heavy weight quality to BSEN 10255:2004. All joints shall be screwed except at inlet breeching positions and landing valve positions in which case flanges shall be installed to BS 4504 galvanised and screwed joints.

All pipe fittings shall be constructed from malleable cast iron galvanised to BS1434: 1986 and BS 1256:2000 and having screwed threads complying with BS 21:1985.

Flanges shall be galvanised to BS4504 and complete with sheridised nuts, bolts and washers. Joint rings are to be full faced and manufactured by 3MM “Klingerite” sheeting or equal. Nuts, bolts shall be of a type resistant to tampering or unauthorised removal.

Joints are to be made with long hair silken hemp and jointing paste to BS 21:1985.

Inlet breeching and outlet cabinets shall be built in type finished stove enamel red with Georgian wired glass door and signed in accordance with BS 5041:part5 (1974). Cabinets to be complete with keyed slam locks.

Breeching pieces are to be twin inlet type sized at 63mm diameter complete with quick release cap and chain flanged to BS 4504 in accordance with BS 5041:part 3(1975).

Landing valves are to be gate valves, brass with quick release cap and chain, flanged to BS 4504 in accordance with BS 5041:part 2(1975).

Air release valve shall be installed on top of riser and shall be 25mm BSP screwed male end type.

#### **1.45 DRAINAGE**

##### Above Ground Drainage:

All works shall be in accordance with BSEN 12056:2000 ‘Code of Practice for Sanitary Plumbing’ the Building Regulations Part H and shall comply with the Local Authority Byelaw requirements.

All statutory notices legally required for the works shall be given by sub-contractor to the required statutory bodies.

The sub contractor is to co-ordinate the installation of the above ground drainage.

The work shall be carried out to the complete satisfaction of the Contract Administrator and the Local Authority.

The soil and waste pipe systems have been designed on the modified single stack system of drainage whereby some anti-siphon pipe work is required generally as indicated on the drawings.

Internal main stack pipes to BS EN 877:1999, branch soil pipes, floats and stubs shall be installed in uPVC to BS 4514 jointed by means of solvent welding and supported with galvanised standard brackets, where stacks are installed in high riser (over eight stories) buildings they shall be in cast iron.

Intumescent fire sleeve shall be fitted to all stack pipes where passing through compartment floors and walls.

Branch waste and anti-siphon pipe work shall be installed in PVC to BS 5255 jointed by means of solvent.

Where standard brackets cannot be used purpose made brackets in galvanised mild steel shall be used to ensure adequate support for the pipe work and keep alignment correct.

All stacks pipes shall be installed plumb and straight, adequately supported and jointed in correct manner as recommended by the manufacturer of the pipe work.

All open ends of pipe work left during construction shall be temporarily sealed with plugs to prevent foreign matter entering the system.

Correct adapters shall be used for jointing different materials together.

Expansion joints shall be installed in the PVC pipe work to facilitate thermal movement in accordance with the manufacturer's printed instructions; anchor or fixed points shall be provided to control thermal movements.

Access doors, pipes and rodding eyes are to be installed in the pipe work to enable the whole system to be cleaned, rodded and tested.

All fittings, other than WC's shall be fitted with a white polypropylene deep seal trap to BSEN 274:2002 with union inlet and compression outlet to sizes indicated on the drawings.

The maximum distance between supports shall be as follows:

	<u>Vertical</u>	<u>Horizontal</u>
UPVC pipes 20mm – 40mm	1.2m	0.5m
50mm	1.2m	0.5m
75mm – 100mm	1.8m	0.9m
Cast iron pipes 75mm – 100mm	3.0m	1.0m

All pipe work shall be tested in stages and upon completion of the work by means of air pressure, the system shall be capable of sustaining 75mm WG for 5 minutes or as approved by the Local Authority.

The Local Authority must be in attendance to approve the final testing.

Fix only new sanitary ware as indicted on the Architects drawings and to detail specified by the Architect.

Overflows shall be installed in PVC shall comply with relevant Water Regulations.

### Below Ground Drainage:

The contractor shall produce working drawings and issue them to the Contracts Administrator for comment before any installation works take place. Connections to the existing local authority services shall be agreed and arranged with the local authority.

The contractor shall be responsible for all new connections required to statutory utilities existing services.

Before work commences, the contractor shall check all invert levels and positions of existing drains, sewers, inspection chambers and manholes against information shown on the tender drawings and report any discrepancies to Engineer/Architect.

The contractor shall adequately protect existing live drains and maintain normal flows during alterations. All existing drains no longer required will either be adequately sealed at both ends and filled with pulverised fuel ash or completely removed.

The contractor shall flush out the whole of the installation both new and existing to remove all silt and debris before final testing, before CCTV inspection and immediately before handover. Safely dispose of washings and any detritus without discharging them into the sewers or watercourses.

The underground drainage installation shall be in accordance with the requirements of BS8031 "Building Drainage", and the requirements of the Local Authority.

Under slab drainage shall be installed in plain ended vitrified clay pipes and fittings to BS EN 295 Part 1 jointed with polypropylene push fit couplings as manufactured by Hepworth Building Products.

The sides of pits and trenches shall be adequately supported at all times but must be removed sufficiently to permit compacted filling of all spaces.

Trenches shall be excavated to the required depth and line and should be as narrow as possible but not less than the pipe diameter plus 300 mm. The sides of the trenches must be vertical from the bottom up to 300mm above the crown of the pipe. All hard lumps, boulders and projections on the trench bottom shall be removed; soft spots shall be hardened by tamping in bedding material.

All trenches shall be kept free from water whilst installing pipelines; trench bottoms shall also be protected against disturbance by foot traffic.

Trenches in areas of fill or in disturbed ground shall be made up with ballast rejects and/or small hardcore less than 75mm and topped with 50mm concrete blinding to form trench bottoms.

External drains with a cover depth of 600mm or more shall be laid a minimum of 100mm thick granular bed with the remaining trench filled to a level at least 100mm above the pipe crown.

External drains less than 600mm cover and those below the building slab shall be encased in a minimum of 150mm of concrete, flexibility being maintained by means of the insertion of a 25mm thick polystyrene board at each joint pre-cut to the pipe diameter and equal to the cross sectional area of concrete.

The trench bottom shall be filled with a layer of granular material to BS 822 (10mm single sized) and be thoroughly compacted to a depth of 100mm across the whole width of the trench, hand holes being scooped out at each joint to enable pipes to rest informally on their barrels. After testing, lay and compact further granular material in 100mm layers to 100mm above the crown of the pipe. Ensure that the pipes are not displaced or floated as compaction takes place.

Backfilling the trenches shall be with selected back fill from site or imported and shall be readily compacted spoil, free from large than 40mm stones, building rubbish, roots vegetable matter, frozen soil and lumps large than 75mm and shall be laid and compacted in layers of 150mm minimum over the whole trench area to a depth of at least 300mm over the crown of the pipe, backfill above this level shall be laid and compacted in layers not exceeding 300mm loose depth.

There must be at least 600mm of compacted backfill before any mechanical compaction takes place.

All “Y” branches on the main drain run shall be at 135 degrees.

Bends, gullies and other terminal fittings shall be bedded and set in concrete.

Where branch drains run at steep slopes and connect into main runs, adequate concrete thrust blocks shall be provided to prevent undue stresses on the main drain and forcing it out of alignment.

All open ends of pipes and manholes shall be temporary sealed to prevent ingress of debris.

All cement used in connection with drainage works shall be sulphate resisting.

Bends at the foot of the stack pipes shall long radius with duct foot set plumb on concrete bed and haunch.

Flexible joints shall be installed to all inlets and outlets of manholes as close as practicable to the external face of the manhole wall but not more than 150mm away.

Where drains exit the building 2 No. Flexible joints shall be installed to form a rocker pipe and be located as close as practicable to the building wall, concrete lintels or pipe sleeves shall also be provided and installed with a clear 50mm void around the drain filled with foam to prevent ingress of concrete and debris.

All drains shall be laid in straight lines and to one gradient between manholes of access points.

Correct adapters shall be used when connecting new drainage to existing or to different materials.

Yard gullies shall be Hepworth RGP5 225mm diameter x 585mm deep complete with RGP6 grating and IBP3 basket.

Gullies for drainage of RWPs shall be Hepworth figure SG1/2 trap and SH3/2 square top hopper with back inlet where required and fitted with grating and frame.

Manholes 1.2m or less shall be constructed in 225mm thick semi engineering brickwork jointed in English bond flush pointed, ensure all joints are solidly filled with mortar. Bricks are to be solid type similar to ‘south waters’ and frogs laid upwards.

Manholes over 1.2 metre deep shall be constructed in pre-cast concrete sections to BS 5911 surrounded with 150mm graded concrete and tied into the structural concrete foundation raft by means of reinforcing rods, ensuring all joints are well buttered up in 1:1 cement/sand mortar and finished smooth and flush on completion.

Shallow manholes were indicated on the drawings and less than 900mm deep can be one piece polypropylene and surround in 1500mm of concrete, tied into the raft with reinforcing rods.

The mortar mix shall be 1.3 cement/sand Sulphate resisting.

All manholes shall be built up from 200mm thick concrete bases.

Open channels in the bottom of manholes shall be formed with half round channels, tapers or beds as may be required. Branch channel bends shall be standard half section with uniform 250mm projections.

Step irons in galvanised malleable iron to BS 1246 shall be built into the manhole walls where the depth from the surface to the invert exceeds 900mm. The first step iron shall be 450mm from finished level at 300mm centres on plan and 300mm vertically in a staggered fashion.

Backdrops, vertical drops shall be installed in vitrified clay pipe work and fittings external to the manhole and surrounded in 150mm minimum of concrete. The manhole base slab shall be oversized when poured with an overhand to accommodate the load of the backdrop. Internal cast iron drain backdrops can be used where space allows, and shall have a square door access bend on top.

Benching in manholes shall rise vertically from the top edge of the channel to a height, not less than that of the soffit of the outgo, and be sloped upwards at 1:12 to the edge of the manhole wall. Rough concrete benching using 10-14mm aggregate shall be gloated over to a smooth hard finish with a coat of 1:2 cement/sand mortar laid monolithic with the benching. The top of the vertical section of the benching shall be rounded off to a 25mm radius.

Branch drain benching shall be shaped around the channel branches as to guide the flow of effluent in the direction of flow.

Gullies in paved areas are to be trade Nickel Bronze finished as detailed on drawings.

Branch connections at manholes are to be formed using half round slipper bends in direction of flow.

Alterations of existing manholes shall be reconstructed as described for new manholes.

Manhole covers and frames positioned externally and in the car port shall generally be cast iron in accordance with BSEN 124:1994 medium duty generally and heavy duty where subject to lorry and heavy good vehicles.

All covers are to be fully accessible and visible.

Manholes covers and frames shall be set square and level, well bedded and haunched in concrete and are to be drainage system types as noted on drawings.

All covers shall be set in grease after final testing and completion of the works.

Where manhole covers are located in the paved landscape or as in accordance with the Architects requirements the manhole covers shall be a brick pave recessed manhole cover with galvanised steel frame and shall be typical of the following:

Heavy duty manholes covers manufactured by Drainage Systems type no. 6333 in locations where vehicular access is required.

Medium duty manhole covers manufactured by Drainage Systems type no. 6332 in locations restricted to Pedestrian Access.

The above manhole covers to be suitable to receive the landscape paving blocks specified by Architect.

The Contractor is to provide clean water, assistance and apparatus for testing and inspections as required.

Testing, all drain runs shall be tested before backfilling is commenced, and again upon completion of backfilling and reinstatement to ensure the soundness of the system, any defects are to be corrected at the Contractor's expense.

All testing shall be in accordance with the code of practice for drainage BS 8301 and as required by the Local Authority.

Due notice shall be given to the Local Authority and the Contract Administrator to be present when a particular line is being tested, and only when approved shall backfill be commenced.

On final tests a certificate shall be presented by the Contractor for signature by the Local Authority and/or Contract Administrator.



The Contractor is to allow for a CCTV video survey of the complete system to be carried out, drainage, this is to be undertaken when all tests and reinstatement works have been completed, a copy of the video and report shall be issued to Contract Administrator before handover.

Existing drainage runs not required for the new works shall be grubbed up, in filled with concrete or sealed by means of a drain plug and concrete packing. Unwanted slipper bends in manholes shall be removed the drain plugged and benched over to the lines of the existing benching.

Redundant manholes shall be cut down at least 300mm below finished levels, filled with hard-core and topped over with 150mm thick concrete.

The Contractor is to provide his own drawings locating all underground drainage points, manhole positions and gullies etc. and shall liaise with the mechanical sub-contractor to ensure that drainage points are correctly positioned to suit the above ground drainage.

At completion of the underground drainage works record drawings shall be prepared by the Contractor, a copy of which shall be issued to the supervisory officer for comment, two weeks before handover.

#### **1.46 CHLORINATION AND WATER SAMPLING**

After all work has been completed on the hot and cold systems, these shall be sterilised/chlorinated in accordance with BS 6700:2006 Section 13.9 generally, as follows:

Before chlorination, service pipes, tanks and cisterns shall be flushed out to remove dirty water, debris etc., refilled with clean water and flushed again.

No water shall be used for domestic purposes during this flushing operation, nor until chlorination has been completed.

The whole of the water services apparatus is to be filled with a solution of 50 p.p.m. (50 mg per litre) chlorine in water. The solution shall be distributed throughout the system and remain in the system for 24 hours and longer if conditions demand and at the end of this period the chlorine residual in all parts of the system should be at least 30 p.p.m. Tests of the strength of the solution shall be carried out periodically and in the presence of the Contract Administrator.

Warning notices must be placed at all entrances to the building whilst chlorine is in the system.

Chlorine concentrated solution is to be mixed with the water in the break tank (if any) and the cold water storage cistern, then the pump (if any) operated and all taps opened and flushing cisterns operated until the resultant diluted solution is drawn through the whole of the pipe work system at a concentration of 50 p.p.m.

When satisfactory, sterilisation has been effected the system is to be thoroughly drained, refilled and drained again before finally filling for use, ensuring that the free chlorine concentration is no greater than 0.5 p.p.m. Or that present in the water supply mains, whichever is the greater. Mains cold-water services shall be carried out in a similar manner except chlorine solution shall be injected into the mains distribution pipe work.

At the end of the Contract, but prior to handover, the Contractor shall take samples of water from the following points in the system:

- a. Rising main to cold water tanks;
- b. From the boiler drain cocks or other lower points in the system.

These samples shall be analysed and the Contractor shall report to the Contract Administrator.

At the same time the Contractor shall report to the Contract Administrator any discolouration of the water in the systems.



#### **1.47 BOILER DOSING EQUIPMENT**

The following equipment shall be installed:

- a. 15 litre dosing pot in the boiler house suitable for the system pressure.
- b. Filling funnel connected to dosing pot with cover, lockshield valve and drain valve.

The pot shall be connected to the system pipe work with lockshield valves.

A line constructed from light gauge copper tube shall be run from the drain valve to the nearest gully.

#### **1.48 FLUSHING OUT**

Prior to commissioning the system, and in the presence of the Contract Administrator, the whole of the pipe work shall be flushed out by the Contractor by connecting a high pressure pump to the pipe work and running the waste water to drain.

The Contractor shall ensure that all pipe work is free of scale and other sediments and the process shall continue until the Contract Administrator is satisfied that the pipes are free from all foreign matter.

It is the responsibility of the Contractor to allow adequate connection points on the pipe work for the pump connection and to supply suitable pumps and hoses. A Practical Completion Certificate will not be issued unless the above process has first been completed.

This process shall be in accordance with Application Guide 1/89 "Flushing and cleaning of water systems" (June 1989) as published by B.S.R.I.A.

#### **1.49 COMMISSIONING**

The commissioning of the building services systems shall be overseen by commissioning agent, see particular specification, and the following clauses. The commissioning should be carried out to the CIBSE code M "Commissioning Management (2003)" and BSRIA Guides A/G 5/2002 "Commissioning Management" and A/G 16/2002 "Variable Flow Water Systems, Design, Installation and Commissioning Guidance".

#### **1.50 COMBUSTION EFFICIENCY TESTS**

A combustion efficiency test shall be carried out on the completed boiler installation in accordance with CIBSE Code B-Boilers (2002). The Contractor may carry out the tests providing he has the necessary experienced staff and instruments available. Alternatively, the Contractor shall arrange for the tests to be carried out by a competent independent authority.

All necessary access shall be allowed for by the contractor.

The Contract Administrator or his representative shall be given due notice when testing is to be carried out and shall be present at each test.

The tests shall demonstrate to the Contract Administrator that the combustion efficiency of each boiler is not less than that guaranteed by the Contractor in his tender. The combustion efficiency shall be based on flue gas temperatures taken at the flue gas exit from each boiler. A period shall be allowed to permit steady state conditions to be reached before testing takes place, and to assist in maintaining a steady rate of firing, the automatic control arrangements may be rendered inoperative for the period of the test.

It is the responsibility of the Contractor to provide copies in duplicate of the test figures obtained, and costs incurred shall be included in his Tender Sum.

The boiler(s) shall be commissioned strictly in accordance with 'Commissioning code B: Boiler plant' published by the Chartered Institution of Building Services Engineers.

### **1.51 SYSTEM PERFORMANCE TESTS – HEATING SYSTEMS**

The Contractor shall allow in his tender for carrying out heating system performance tests. The tests may be witnessed by the Contract Administrator or his representative but in any event the Contractor shall provide the Contract Administrator with records of the performance tests prior to the plant being handed over to the Employer. Prior to the tests the system shall be hydraulically balanced and all controls shall be operational.

Balancing shall be carried out strictly in accordance with "Commissioning Code W: Water Distribution Systems" published by the Chartered Institution of Building Services Engineers and the commissioning water systems application principles AG 2/89.3:2002, AG 2/89.2 Commissioning of water systems in buildings, and AG 20/95 Commissioning of pipe work systems – design considerations AG 16/2002 Variable flow water systems design, installations and commissioning guidance, AG 1/2001 Pre-commissioning cleaning of pipework systems published by the Building Services Research and Information Association (BSRIA).

- a. Demonstration that the installation is capable of providing the internal design temperatures. Tests will not be deferred until the outside temperature is coincident with the design outside temperature.
- b. Demonstration that all controls, time switches are operational and that all safety devices work. Thermograph readings will be required as evidence that control systems are operational.
- c. Check of all thermometers.
- d. Check of all motors, pumps, etc.
- e. Check of all pumps.
- f. Check of pressurisation fill unit, expansion vessels and pressure controls.

Test No. (a) shall be recorded in the following manner:

- a. Outside temperature: - Initial, final and weather.
- b. Boiler flow and return temperatures, zone and where needed flow and return temperatures to risers or sub-zones.
- c. Individual room temperatures.
- d. Individual radiator flow and return temperatures.

The Contractor shall provide in his tender:

- a. For all tests points so that the tests may be made.
- b. For the attendance of specialists to assist in the tests and for all plant and instruments required to carry out the tests.

### **1.52 SYSTEM PERFORMANCE TESTS – HOT AND COLD WATER SERVICES**

The Contractor shall allow in his tender for carrying out hot and cold water system performance tests. The tests may be witnessed by the Contract Administrator or his representative but in any event the Contractor shall provide the Contract Administrator with a record of the tests prior to the plant being handed over to the Employer. Prior to the tests being carried out the systems shall be hydraulically balanced and controls shall be operational.

The hot and cold water services shall be commissioned directly in accordance with 'Commissioning code W: Water Distribution Systems' published by the Chartered Institution of Building Services Engineers and the Application Guide 2/89 AG 2/89.3:2002 "Commissioning water systems application principles" AG 2/89.2 Commissioning of water systems in buildings, A/G 1/2001 Pre-commissioning cleaning of pipework systems and AG 16/2002 Variable flow water systems design, installation and commissioning as published by BSRIA.

Notwithstanding the provision of the above code, the following tests shall be performed:

- a. Outflow tests which shall be carried out and recorded as recommended in B.S. 6700:2006 or BS CP 342:Part 2:1974, as appropriate.
- b. Record of pressure at appropriate points throughout the systems. Initial and final pressures should be given.
- c. Demonstration that the heating surface in cylinder or calorifiers is as specified. Record initial and final temperatures and times.
- d. Demonstrate that all controls, thermostatic valves and hand operated valves are operational.
- e. Record surface temperatures over lagging on cylinders for the recorded storage temperature.
- f. Confirm that there is no evidence of noise or water hammer under the various test conditions.

The Contractor shall provide in his Tender:

- g. For all test points so that the tests can be made.
- h. For the attendance of specialists to assist in the tests and for all plant and instruments required to carry out the tests.

### **1.53 SYSTEM PERFORMANCE TESTS – GAS SYSTEMS**

The Contract Administrator requires the Contractor to test the entire gas piping system. These tests may be witnessed by the Contract Administrator or his representative but in any event the Contractor shall provide Test Certificates as proof that the tests have taken place. Where piping and fittings are to be buried, test shall be made before the piping is buried, i.e. the installation shall be tested in sections if the programme of work so indicates.

A final test shall be made on completion. The test(s) is to be made with air under pressure to 900 mm water gauge or twice the working pressure whichever is the greater. The pressure shall be held for 20 minutes and the test shall be satisfactory if there is no fall in pressure during that time. If the test shall be unsatisfactory the work shall be made good and the test re-applied. The cost of the test(s) and the necessary plant and instruments shall be the Contractor's responsibility.

When appliances have been connected to the supply the Contractor shall demonstrate to the Contract Administrator or his representative that the system and appliances are satisfactory. The Contractor shall allow in his tender for the attendances of British Gas and any appliance manufacturers as necessary to assist in the test and demonstration of the system.

### **1.54 SYSTEM PERFORMANCE TESTS – VENTILATION SYSTEMS**

The Contractor shall allow in his tender for the carrying out of ventilation system performance tests. The tests may be witnessed by the Contract Administrator or his representative but in any event the Contractor shall provide the Contract Administrator with records of the performance tests prior to the plant being handed over to the Employer.

The ventilation system shall be commissioned strictly in accordance with "Commissioning code A: Air distribution systems", published by the Chartered Institution of Building Services Engineers and Commissioning air systems application procedure for buildings AG 3/89.3:2001 and AG 1/91 Commissioning of VAV systems in buildings as published by the BSRIA.

The Contractor shall provide in his tender:

- a. For all test points so that the tests may be made, these are to be sealed for reuse after initial use.
- b. For the attendance of specialists to assist in the tests and for all plant and instruments required to carry out the tests.

Notwithstanding the requirements of the above commissioning code, the following information shall be passed to the Contract Administrator prior to acceptance of the plant:

- a. Velocity of air entering or leaving ventilation terminal unit.
- b. Volume of air entering or leaving ventilation terminal unit.
- c. Velocity of air in main and branch duct.
- d. Volume of air in main and branch ducts.
- e. Static and velocity pressures in main and branch ducts.
- f. Velocity of air entering and leaving fans.
- g. Volume of air entering and leaving fans.
- h. Pressure drop across fan.

### **1.55 SYSTEM PERFORMANCE TESTS – CONTROL SYSTEMS**

The Contractor shall allow in his tender for carrying out control systems performance tests by the controls specialist.

The tests may be witnessed by the Contract Administrator or his representative but in any event the Contractor shall provide the Contract Administrator with a record of the test prior to the plant being handed over to the Employer.

The control system shall be commissioned strictly in accordance with 'Commissioning code C:' published by the Chartered Institution of Building Services Engineers.

### **1.56 SYSTEM PERFORMANCE TESTS – REFRIGERATION SYSTEMS**

NOT USED

~~The Contractor shall allow in his tender for the carrying out of performance tests on the refrigeration system installed (VRV, Split or Multi-split, etc.).~~

~~The tests may be witnessed by the Contract Administrator or his representative, but in any event the Contractor shall provide the Contract Administrator with records of the performance tests prior to the plant being handed over to the Employer.~~

~~The refrigeration systems shall be commissioned by the Specialist Contractor and in accordance with "Commissioning Code R: Refrigerating systems" TM 1/88.1 and TM 44 inspection of air conditioning systems as published by the C.I.B.S.E.~~

~~Notwithstanding the provision of the above codes the following tests shall be carried out.~~

- ~~a. Demonstration that the installation(s) is capable of providing the internal design temperatures either heating or cooling mode as necessary to meet the room heating or cooling load requirements. Tests will not be deferred until the outside temperatures or room load conditions are coincident with the design parameters. In this respect forced heating or cooling loads are to be made available by the Contractor (i.e. temporary heaters/coolers) for these testing purposes.~~
- ~~b. Demonstrations that all controls, time switches and safety devices are operational.~~
- ~~c. Thermograph readings will be required as evidence that the system(s) are functioning correctly. Such testing instruments shall be provided for by the Contractor and allowed for in his tender.~~

- ~~d. All remote room units, fan coil units, ceiling cassettes, etc., are to be tested as an integral part of the refrigeration system.~~
- ~~e. All refrigerant gas operating pressures (suction/liquid) temperatures, etc., at each piece of equipment is to be checked and recorded in accordance with the relevant C.I.B.S.E. Code.~~

### **1.57 THERMAL MODELLING**

In accordance with the requirements of the latest Building regulation L and all it's relevant sub parts, the contractor shall allow within the Tender costs to provide a thermal modelling report on the project, that will give all information on the project regarding the thermal performance, target and final CO2 emissions and confirmation of compliance with the Building regulations against a notional building.

### **1.58 GENERAL DUCTWORK**

The ductwork services installation shall follow the details set out in the accompanying documentation, the Chartered Institute of Building services engineers and shall be installed in accordance with the recommended publications by the heating and ventilating contractors association entitled:

DW/143 A practical guide to ductwork leakage testing  
DW/144 specification for sheet metal ductwork  
DW/154 Specification for plastic ductwork  
DW/172 standard for kitchen ventilation systems  
DW/191 Guide to good practice glass fibre ductwork  
TR19 Internal cleanliness of ventilation systems.

### **1.59 DISTRIBUTION DUCTWORK**

Ductwork, Fittings and Supports:

Low Velocity:

This section is based on the Heating and Ventilating Contractors Association Specification DW/144 for rectangular and circular and oval ductwork.

This Specification applied to systems having average velocities not in excess of 10 m/s, and positive and negative static pressure not greater than 5 millibars for plant connections.

Unless indicated to the contrary on the Tender Drawings, bends, branches, tees, expansions, contractions and changes of shape shall be in accordance with the Standard Specification. Where the Standard Specification is in conflict with the drawings, the drawings take precedent.

### **1.60 DUCTWORK**

The Contractor shall supply, deliver and install the complete range of ductwork, in accordance with this Specification.

The Contractor shall check the building dimensions and the dimensions of plant on Site before the fabrication of ductwork is started. Working drawings shall be submitted to the Contract Administrator prior to manufacture.

The ductwork shall be constructed from best quality galvanised mild steel sheets, braced and stiffened, in accordance with DW/144, published by the Heating and Ventilating Contractors Association.

Square or mitred bends shall only be installed when agreed. Transformation or taper pieces shall be fabricated so that the angle on any side does not exceed 22.5%. Ductwork and supports shall be fabricated without sharp corners and edges.

All flanged joints shall be provided with a full faced rubber gasket and, where slip joints occur, they shall be sealed by non-hardening sealing compound and adhesive tape.

The Contractor shall ensure that all bends have a throat radius of at least half the width of the duct and bends fitted with air turns shall be used where indicated on the drawings and shall be of the double skin aerofoil pattern.

All supports and brackets shall be painted with one coat of red oxide to and after erection. All nuts and bolts shall be sheradised.

Where ductwork passes through the building fabric, galvanised steel sleeves shall be provided. A glass fibre packing shall be inserted between the ductwork and sleeve to prevent transmission of air and noise from one space to another and the effects of vibration on the structure.

The Contractor shall make provision for cleaning the ductwork system with an efficient vacuum cleaning plant immediately prior to initial operation of the system.

#### Plastic Ductwork:

Plastic ductwork and fittings are to be of high impact, rigid, un-plasticised P.V.C. having a tensile strength of not less than 5 lb bars per 25 mm notch (charpy) at 20 deg. C.

They should be of light grey colour with factory welded joints and provided with socket and spigot joints for site erection.

All site joints must be airtight and made with a suitable solvent cement conforming with a specification to be approved by the manufacturers of the plastic ductwork.

#### Sheet Metal Ductwork:

The thickness of ductwork and the stiffening to be used must be in accordance with the recommendations contained in the D.W. 144.

External ductwork, including that exposed on roof, to be at least 16 gauge, galvanised after manufacture, and must conform with the current Building Regulations. All ductwork used in bathroom or toilet extract systems shall be constructed from a minimum of 16 gauge sheet steel, galvanised after manufacture.

All joints on rectangular ducts with the longest side equal to or greater than 600 mm shall be flanged.

All angle, channel and flat mild steel duct supports, etc., are to be galvanised (welded work to be galvanised after manufacture), zinc sprayed or otherwise rust-proofed although not specifically mentioned under each clause.

All constructional joints, seams, etc., are to be close riveted with rivet spacing at not more than 75 mm centres, made in an approved manner. Welded joints must not be used except in special circumstances, and then only with the approval of the Contract Administrator.

Where ductwork is visible no seams will be allowed on the side or sides exposed to view.

All bends are to have a minimum radius to centre line of duct, equal to the width of duct except where otherwise indicated.

All connections to plant and masonry shafts, etc., are to be made with angle iron flanges with insertion pieces to minimise the transmission of vibration and to form airtight joints.

Test holes are to be provided in ductwork in suitable positions sealed after initial use for future reuse.

No permanent erection of the work shall be carried out until the builders work ducts, false ceilings, partitions, walls, timber and other builders work in connection with the ventilation services have been approved by the Contract Administrator.

All joints shall be secured with rivets and sealed in an approved manner. The ductwork shall be constructed from M5 sheet galvanised after manufacture and all cut edges shall be wire brushed and painted with two coats of "Galvatite".

All external uninsulated ductwork shall be painted with two coats of bitumastic paint on completion. Where there is any corrosion the metal shall be wire brushed prior to painting.

All brackets shall be wire brushed and painted with two coats of (non lead based) paint after installation. Where ductwork passes through roof the Contractor shall supply and install a suitable weatherproof collar to allow the roof to be sealed.

### **1.61 CLEANING/ACCESS DOORS**

Access openings shall be provided in ducting systems adjacent to the following items of equipment. Fire dampers, smoke dampers, automatic temperature and humidity detecting equipment, on each side of "inline" fans, filters, heater batteries and other items of equipment also access doors for "duct cleaning" at commissioning and future. All kitchen extract ductwork cleaning doors located to facilitate complete cleaning of the entire duct run, as required by DW/172.

Where possible openings shall be 375 mm wide by 300 mm high with cover plates constructed from galvanised mild steel. The opening in the duct shall be adequately reinforced, with the cover being made air tight by means of a rubber gasket, held by a minimum four threaded bolts and wing nuts.

All ductwork shall be thoroughly cleaned prior to final commissioning air/balancing and be sterilised.

### **1.62 DAMPERS (AIR HANDLING PLANT)**

Dampers to facilitate control and regulation of the air flow shall be provided in the positions indicated in the Tender Drawings. Control dampers shall be selected to match the characteristics of the system to which they are to be installed and sized in accordance with the manufacturers recommendations.

Where the selected damper is smaller than the cross sectional area of the plant or duct in which it is be installed, the Contractor shall install a blank off plate in the plant to prevent air by-passing the damper installation. Dampers shall be constructed to prevent no more than 5 percent air volume leakage when in a closed position and subjected to a static pressure of 1500 kn/m squared (6 ins H20).

Blades may be of hollow section galvanised sheet steel, 18 gauge minimum, or may be formed from two sheets or galvanised sheet steel, 22 gauge minimum, spot welded together to form a rigid blade section. Blades shall be mounted on square section steel spindles, shouldered and turned at the ends to fit into suitable bearings. Blades may be fitted with felt or butyl rubber edging strips in order to achieve the specified leakage rate.

Damper frames shall be formed to provide flanged duct, plant or builders work connections and suitably drilled for matching flanges. Flanges may be of standard mil steel angle section galvanised after manufacture, or be an integral part of the damper frame and formed from galvanised sheet steel.

Frames shall be constructed from 13 gauge minimum, galvanised sheet steel and formed into a "hat shaped" channel section, the completed frame being made rigid by corner braces. Bearings may be of either bronze or nylon with oil impregnated sintered metal bushes or alternatively may be of the ball race type.



Individual blades shall not exceed 225 mm in width of 1500 mm in length and larger dampers shall be multi-leaf equipped with linked operating gear. Inter-connection blade linkages shall be external to the conditioned air stream.

Automatic dampers shall be provided with a suitable galvanised steel pedestal for mounting the operating motor or thruster out of the air stream. Manually set dampers shall be provided with operating arm, position indicating plate and locking mechanism.

Approval of the proposed dampers shall be received from the Contract Administrator prior to the installation being commenced.

### **1.63 DUCT MOUNTED DAMPERS**

Dampers to control and regulate the air flow in supply and return air ducts shall be provided as agreed

Damper blades in rectangular ducts shall not exceed 225 mm in width and 1500 mm in length and larger dampers shall be multi-leaf equipped with linked operating gear to provide opposed blade movement. Blades shall be of hollow section constructed from galvanised sheet steel of not less than 18 gauge, mounted on square section steel spindles, shouldered and turned at the ends to fit into suitable bronze, nylon or ball race bearings. Blade tips may be felt tipped to prevent air leakage when in closed position.

Damper frames shall be formed from galvanised mild steel sheet or not less than 13 gauge formed into a channel section to make a rigid rectangular assembly. Flanges shall be drilled for matching flange connection, and shall project sufficiently to give protection to the blade linkages, which shall always be located out of the air stream and readily accessible.

Manually set dampers shall be provided with an operating arm and locking and indicating quadrant, and marked after balancing.

Where the operating arm is located at high level relative to the floor, dampers shall be provided with remote operating gear of the sheathed flexible cable type. The operating mechanism shall be such that no undue strain is placed in the cable and that movement may be achieved without excess effort.

An externally mounted dustproof cover shall enclose the gearing and be complete with coloured visual blade position indicator and locking wheel.

The damper casing shall be of double skin construction manufactured from roll formed galvanised 16 gauge steel outer frame and 20 gauge steel inner frame. The outer frame shall have continuously welded corners and integral peripheral flanges pre-punched with elongated holes for ease of duct attachment and infinite height adjustment.

### **1.64 TERMINAL DAMPERS**

Grilles and air diffusers with rectangular neck connections shall be provided with an opposed blade damper, screwed or riveted to the neck connection and designed specifically to facilitate the final balancing of the system.

Damper frames, blades and operating mechanism shall be constructed from an aluminium alloy or alternatively from mild steel suitably finished to give full protection to the material during its designed working life.

Blades shall be made of solid section material and shall be firmly held in position by a spring steel retaining mechanism. The blade setting mechanism shall be accessible through the grille or diffuser blades and shall be suitable for operation with an Allen Key.

Where dampers are visible through grille or diffuser they shall be finished with a matt black paint.



### 1.65 FIRE/SMOKE DAMPERS

Fire dampers shall be constructed to meet the test requirement laid down in B.S. 476, with a one hour fire resistance. For in duct air velocities of up to 7.75 m/s the following types of damper may be used. Dampers are to be out of air stream type complete with adjacent access panel.

Single blade vertical sliding, single or multi-blade hinged, single blade offset hinged or the vertical shutter type. In vertical shafts multi-blade types shall not be fitted.

Each fire/smoke damper assembly shall be held in the open position by a fusible link or thermal cartridge, designed to release the damper blade(s) at a temperature of 72°C, complying with BS5588 Part 9:1999.

Each fire damper shall have at least the same standard of fire resistance as the wall or floor, which the duct passes; unless otherwise indicated it shall have a fire resistance rating of one hour (B.S. 476:24: 1987). When a fire resistance rating of four hours is required either two dampers - on each side of the wall or floor - or a single damper having a fire resistance rating of four hours certified by the Fire Research Station shall be provided.

In a horizontal duct the fire damper may be of either the single bladed or the multi bladed pivoted type, in a vertical duct the closing force shall be provided by a stainless steel spring. A multi-bladed damper longer than 1000 mm shall be controlled by two linkage tie rods. Each fire damper shall be of 1.6 mm thick sheet or steel/asbestolux/steel sandwich of equivalent fire resistance.

It shall be galvanised or otherwise treated after fabrication to prevent rust. It shall be set in a casing of galvanised sheet steel of at least 1.6 mm thick provided with stiffeners as necessary to support the bearing plates. The clearance between the edges of the damper and the casing shall be at least 0.25 mm for each 25 mm of damper or width. Where the damper will be fitted to a wall or floor the casing shall be provided either with lugs for building in or with a frame of angle iron not less than 35 mm x 35 mm x 6 mm at each end. Each fire damper blade shall be fixed off centre to a substantial steel spindle which shall rotate freely in bearings supported on the outside of the casing. The damper shall close against a 25 mm x 25 mm x 3 mm angle iron stop fixed to all four sides of a rectangular casing or to the full circumference of a circular casing.

Multi-leaf damper blades shall overlap by at least 20 mm.

Prior to the installation of any fire damper the Contractor shall receive approval from the Contract Administrator or his representative, and the local Authority if required to do so.

### 1.66 ATTENUATORS

The Contractor shall supply, deliver, install, test and commission all attenuators.

All attenuators shall be as selected from the list of preferred manufacturers. Each attenuator shall be selected to ensure a pressure drop of not more than 50 N/m squared.

Rectangular Attenuators:

Attenuators shall be purpose built units constructed by a specialised supplier to meet the performance design criteria laid down in the current C.I.B.S.E. Guide or HVCA standard for kitchen ventilation systems DW/172.

The attenuator casing shall be constructed from galvanised mild steel sheet with longitudinal lock formed joints. End flanges shall be fabricated from mild steel angles and galvanised after manufacture. Casings and flanges shall be to the following minimum gauges and sizes:

<b>Attenuator Longest</b>	<b>Casing Gauge</b>	<b>Angle Iron Flanges</b>
Up to 450 mm	20	25mm x 25mm x 3mm
450 mm - 915 mm	18	38mm x 38mm x 5mm

915 mm - 1220 mm	18	50mm x 50mm x 5mm
1220 mm and above	16	50mm x 50mm x 5mm

Acoustic splitters shall be rigidly held in place within the attenuator casing and shall be an incombustible and inorganic material of low or non-hygroscopic nature. Exposed surfaces shall be bonded or covered to prevent erosion of the surface particles by the air stream, and must be suitable for insertion into air streams with a velocity of up to 25 m/s.

### **1.67 GRILLES AND DIFFUSERS**

The Contractor shall supply and install grilles and diffusers in accordance with this Specification.

A foam plastic gasket shall be provided behind each grille and diffuser to prevent streaking of walls or ceilings.

All grilles and diffusers shall be in accordance with those given in the Schedules or shown on the drawings and finished to a colour to be agreed with the Contract Administrator.

### **1.68 WEATHER LOUVRES**

The external weather louvres shall be provided and fixed by the Main Building Contractor and forming part of the external (fabric) appearance of the building.

Louvres shall be constructed of aluminium extrusions and be completely weather-proof. The Contractor shall make due allowance for connecting to these louvres with a permanent fixing and provide a bird mesh screen which shall be fitted at the back of the louver and finished in a synthapulvine or other approved type factory applied finish.

### **1.69 AIR HANDLING UNITS AND FAN COIL UNITS**

Where air handling units are required, these shall be constructed in accordance with the appropriate ductwork specification and as detailed in the particular specification. All as described in the particular specification.

### **1.70 FANS**

It is the Contractor's responsibility when ordering, to ensure that the equipment ordered is suitable for the application to which it is to be put.

All fans shall be supplied with flexible fire resistant duct connections, anti-vibration mountings on channel frames.

#### Axial Flow Fans:

All parts of the fan and accessories not galvanised shall be fully protected against corrosion to the satisfaction of the Contract Administrator by applications of a works primer.

Fans shall be statically and dynamically balanced at manufacturers works within the design operating speed range.

Fans shall be capable of giving the specified performance when tested in accordance with B.S. 848-1:1997. The Contractor shall provide sound power level spectrums and constant speed fan characteristic curves should they be required by the Contract Administrator. Upon receipt of approvals of air handling plant and workshop ductwork drawings the Contractor will be required to re-calculate the final system resistance prior to ordering the fans.

For mounting in ducted systems the fan casings shall be arranged to cover the overall length of motor and impeller, and shall be constructed from heavy steel plate galvanised after manufacture. An inspection door sited to allow convenient access to the driving motor shall be provided, or alternatively the fan casing may be arranged to pivot. The flanges at either end of the fan shall be of heavy gauge steel drilled to accept a matching flange and galvanised after manufacture.

Fan blades shall be of aerofoil section with adjustable pitch angle rigidly held in a spun steel or die cast aluminium alloy hub, fabricated mild steel or moulded glass fibre re-enforced polyester resin.

Motors shall be of the 3 phase squirrel cage induction type, totally enclosed, Class E insulated being suitable for continuous operation in ambient temperatures up to 40 deg.C (104 deg.F). Motor bearings may be of the ball or roller type fitted with lubricators extended outside the fan casings.

Fans shall be provided with an electrical terminal box on the casing, suitable for flexible conduit entry, manufactured from heavy gauge mild steel and galvanised after manufacture.

Axial flow fans driven by an externally mounted motor shall have twin ball or roller bearing mounted steel impeller shaft with lubricators extended externally to the fan casing. Adequate serving doors shall be fitted for access to the belt driven and impeller shaft pulley and the belt tunnel shall be properly sealed within the fan casing to prevent air leakage. Belt tensioning shall be carried out by adjustment of the external motor mounting platform and the belt and external pulleys fully guarded.

### **1.71 FLEXIBLE CONNECTIONS**

Flexible connections shall be fitted to the suction and delivery connections of all fans and all grilles and diffusers located in demountable ceilings. The minimum length of any connection, shall be 50 mm and in no case shall exceed 250 mm in length. Connection to grilles or diffusers to have a minimum length of 1 mtr, to a maximum of 2 mtrs.

Connection shall have a fire penetration time of at least fifteen minutes when tested in accordance with B.S. 476-24:1987.

Rectangular connections shall be made from quality high grade super fine woven glass fibre cloth lined with an impermeable lining applied by vacuum diffusion. Inlet connections shall be made with lapping joint held by removable fixing bands and discharge joints by a 5 mm thick mild steel flat flange.

The flexible connections shall be of the full cross-sectional area of the mating fan connection. The ends of the ducts and fan connection shall be in line.

Where indicated to prevent noise breakout, flexible fan connections shall be of the "Revertex" type.

Flexible connections shall consist of, or be protected by, material having a fire penetration time of at least fifteen minutes when tested in accordance with B.S. 476-24:1987. The material shall be of the glass fibre cloth type, canvas will not be accepted.

The width of the joints from metal edge to metal edge shall not be less than 50 mm and not more than 250 mm.

### **1.72 NOISE AND VIBRATION**

The Contractor shall use the services of an acoustic specialist to advise on design and installation of all noise and vibration attenuating equipment. Particular attention shall be paid to noise and vibration emanating from plant and equipment.

All necessary precautions shall be paid to noise and vibration entering the occupied areas above the design levels specified.

All plant and equipment shall be adequately isolated from the building structure by the use of anti-vibration mountings and flexible pipe and duct connections. Pipe work and ductwork adjacent to vibrating equipment shall be supported from spring type hangers.

Attenuators shall be fitted to supply and extract ductwork to ensure that noise levels specified are not exceeded with the plant operating at full and minimum load conditions.

Insulation shall be applied to ductwork on the system side of attenuators to prevent airborne noise from re-entering the ductwork system where the attenuator cannot be built into plantroom walls.

Attenuators shall be fitted to all outside air intakes and discharges including natural vents to the boiler room to prevent noise pollution of the surrounding areas. Special attention shall be given to noise and vibration emanating from the air cooled condensers.

### 1.73 REFRIGERANT PIPEWORK AND FITTINGS

All refrigerant pipe work used in VRV or split system shall be installed strictly in accordance with the manufacturers recommendations.

Pipe work for refrigerant systems shall be of copper pipe and shall be of refrigeration quality to BSEN 12449:1999, fully annealed (up to and including 7/8" OD only) and internally degreased and cleaned.

The minimum acceptable pipe wall thickness shall be in accordance with Table 5 of the British Standards.

#### REFRIGERANT PIPEWORK:

OD in	1/4	3/8	1/2	5/8	3/4	7/8
Wall Thickness	0.036"	0.040"				
Condition	FULLY ANNEALED					
CD ins	11/8	1	3/8	1 5/8	2 1/8	2 5/8
Wall Thickness	0.048"	0.064"				
Condition	HALF HARD					

#### REFRIGERANT PIPEWORK FOR USE WITH REFRIGERANT R410A

##### Minimum Thickness Of Annealed Copper Pipes

Nom Dia	Outside Dia (mm)	Thickness (mm)
1/4"	6.35	0.8
3/8"	9.52	0.8
1/2"	12.70	0.8
5/8"	15.88	1.0

Joints in copper pipe shall be flanged, flared (up to 3/4" OD (15 mm) only), or brazed (with or without capillary fillings). Brazing shall be carried out to the requirements of the HVCA Code of Practice - Brazing and Bronze Welding of Copper Pipe and Sheet.

Screwed joints will not be accepted in refrigerant pipes except on the equipment accessories. In such cases the threads shall either be of taper form and used in conjunction with PTFE tape or an anaerobic sealant or of parallel form associated with machined join faces and a suitable joint compound.

Plastics pipe with compression fillings will be accepted for feed piping to control cabinet door mounted pressure gauges and similar fittings. The grades of pipe used shall withstand the test pressure applied and the effects of refrigerant and oil. Plastics pipe will not be accepted for any other refrigerant pipe work.

Compression fittings will not be accepted on refrigerant pipe work except as detailed above and on equipment accessories using Refrigerant 11, 113 or 114.

Refrigerant pipe work shall not be arranged for running compressors in parallel (i.e. with common suction and/or discharge pipes). The use of a number of compressors, each having an independent refrigerant circuit in a common evaporator will be permitted providing pressure tests between adjacent refrigerant circuits in the evaporator are carried out during manufacture.

The pipe work shall be designed so that oil in the refrigerant leaving the compressor (and passing any oil separator filled) shall be carried through the system and back to the compressor at the lowest stage of capacity unloading.

Pipe work shall be firmly supported and secured to minimise vibration. Vibration eliminators shall be fitted to the compressor suction and discharge pipes to minimise transmission of vibration of noise. Where indicated, a gas pulsation damper shall be fitted in the refrigerant discharge pipe, in the plantroom, as close as possible to the refrigeration compressor.

After completion the refrigerant pipe work shall be pressure tested as detailed in the Specification.

Pipe work shall be reamed after culling and shall be free from burrs, scales and other defects and shall be thoroughly cleaned before erection. At all times during the installation of the pipe work the Contractor shall keep all ends capped except when actual jointing is taking place and all pipe work shall be kept sealed prior to installation.

Joints are to be thoroughly cleaned to bare metal before being brazed with cuproprotective or silver solder. Flux used for silver solder joints shall not contain ammonia, which is harmful to copper. Whilst pipes are being brazed dry nitrogen is to be passed through the tube at a velocity sufficient to displace the air within the tube.

Horizontal and vertical pipe runs shall be supported on heavy quality galvanised cable trays and shall be clipped and bracketed at 3 metre centres maximum and vertical pipe runs at not more than 4 metre centres. Vertical suction pipe work shall have oil traps at 4 metre centres.

Flexible pipes of the anaconda type shall be installed on all connections to air cooled condensers. Elbows shall not be permitted. Only long radius elbows shall be used.

To ensure that no oxides have formed in the pipe lines after completion of all the pipe joints, but before testing, three brazed joints will be selected at random by the Contracts Administrator or his representative.

The joints selected will be cut through by the Contractor and examined by the Contract Administrator.

If oxides are found in a joint all pipe lines shall be replaced at no extra cost to the Contract.

After examination all joints cut open shall be made good at the Contractor's expense.

During the whole of the pipe jointing operation the Contract Administrator or his representative shall be in attendance.

Every refrigeration system shall be protected by a pressure device unless it is so constructed that pressure due to fire conditions would be safely relieved. The equipment provided shall comply with BSEN 378 Parts 1-4:2000 and the outlet piped to discharge outside the building if bursting discs are used.

A liquid receiver shall be fitted to any system using an air-cooled or evaporative condenser. For systems 70 kW and above, having a water-cooled condenser with insufficient capacity to take the complete refrigerant charge, a liquid receiver shall be provided to make up the deficiency.

Systems using a thermostatic expansion valve shall have the following items preceding it in the refrigerant liquid pipe:

- a. A solenoid valve.
- b. A sight glass.
- c. A refrigerant drier (replacement).
- d. A refrigerant strainer.
- e. A capped refrigerant charging valve.

An evaporator pressure regulating valve, where fitted, shall be protected by a strainer and an evaporator pressure gauge shall be provided up-stream of the valve, fitted with means of isolation.

Units having a direct expansion evaporator at a higher level than the compressor shall operate on a pump down cycle.

Refrigerant stop valves which incorporate a spindle gland shall be of the back seat type. The spindle gland shall be serviceable with the valve 'in situ'.

All compressors shall be provided with oil failure control or protection. Each refrigeration machine shall be provided with thermostatically controlled crankcase heater(s) to ensure that all components of the compressor(s) may be properly lubricated when the compressor(s) start. The operation of the compressor(s) should be interlocked with the crankcase heater(s) to prevent operation until correct oil temperature has been reached.

The crankcase heater(s) shall be provided with an uninterrupted power supply to maintain the temperature at the correct temperature with the machine off but not isolated to provide prompt restart.

Oil cooling may be provided by direct refrigerant injection with hot gas returned to the evaporator. The system shall be automatically controlled as an integral part of the refrigeration machine controls system.

Each separate circuit of each refrigeration machine shall be provided with the following instrumentation:

Discharge pressure gauge, Suction pressure gauge and Oil pressure gauge.

All gauges shall be removable without interruption of the machine operating by provision of gauge cocks - sensor pockets.

Each refrigeration machine shall be provided with a controls panel incorporating all controls and indicators necessary for machine operation. The panel shall incorporate starters, circuit breakers, step controllers, pressure switches, flow switches, temperature sensors, etc., and be complete with door interlocked main isolator.

Access doors shall be hinged and lockable giving access to all items of equipment.

The entire installation shall be arranged for safe and full access, for all routine service and maintenance and also for all plant equipment.

#### **1.74 EQUIPOTENTIAL BONDING**

The following services shall be bonded to the main earthing terminal by means of cupinned lugs, nuts and bolts and labelled to denote size and destination:

- a. Incoming gas service
- b. Incoming water service
- c. Pipe work within plant rooms ducts and risers
- d. Ductwork within plant rooms distribution and risers
- e. Fire hydrant services or dry riser

- f. Each side of pipe or duct with non metallic joint or flexible connection
- g. Intake room switchgear/panels and other earth bars
- h. All items of plant and equipment tanks, cylinders, calorifiers, boilers vessels flues and air handling units etc

All in compliance with the current BS 7671 and part P of the building regulations.

#### **1.75**

#### **NOT USED**

#### **1.76 OPERATING AND MAINTENANCE MANUAL**

In compliance with the Health and Safety at Work Act 1974 the persons in charge of the building or appointed representatives of the Client shall be instructed in the correct operation, control and maintenance of the systems and components.

Operating and Maintenance Instructions, purpose written for these particular works in accordance with the BSRIA Guide BG 79/2020 "Handover operating and Maintenance Manuals and project feed back" shall be provided. The manuals shall be based on the Class 'D' standards and be divided into the following sections:

Introduction/Format of the Manual:

- Section 1 How to use the Manual
- Section 2 Contractual and legal guides
- Section 3 Design intent/parameters
- Section 4 Description of systems
- Section 5 Schedule of systems
- Section 6 Spare parts
- Section 7 Spares policy
- Section 8 Commissioning data
- Section 9 Operation of systems
- Section 10 Maintenance and fault finding
- Section 11 Modification information
- Section 12 Disposal instructions
- Section 13 Names and addresses of manufacturers
- Section 14 "As Installed" drawings
- Section 15 Emergency information
- Section 16 Manufacturer's literature

Particular attention must be given to detailing the controls strategies, control set points, maintenance schedules (every day, every week every month, every three months, every six months, every year etc). Manufacturer's maintenance publications must be included in the manuals.

Three complete sets of the approved instructions secured inside good quality hard cover ring binders of adequate size shall be produced and made available at Practical Completion of the works. Two sets shall be handed to the Client and one set issued to the Principal Designer for inclusion in the health and Safety File.

The installations will not be accepted by the client until the approved manuals have been provided.

### **1.77 RECORD DRAWINGS**

The Contractor shall keep a record as the work proceeds of any work installed not in accordance with the drawings. On completion of the works, the Contractor shall submit a set of drawings showing the works as installed to the engineer for comment/approval. The drawings are to show the exact position of all apparatus pipe work, valves etc., together with diagrams, schedules etc.

After approval of the drawings one complete set of prints shall be provided and included in each Operating and Maintenance Manual and a memory stick of the drawings (Auto CAD DXF File) be supplied to the engineer for retention.

The words "Record Drawings" shall be clearly indicated on all drawings adjacent to the title corner.

General layout drawings must be to a scale of not less than 1:50.

For plant/boiler rooms one copy of schematic and valve chart schedule shall be laminated and installed on an internal wall, once checked by the contracts administrator prior to handover.

### **1.78**

The Contractor to provide a water monitor

Install 'Hevasure Aquilla' water quality monitoring system within the boiler plantroom. (or Equivalent)

This shall be installed and working from the initial fill onwards.

Connect output signals to the Control Panel. BMS to incorporate monitoring and alarm outputs from the Aquilla equipment.