LEHDING SERVICES DESIGN LTD

STANDARD APPENDICES
MECHANICAL SERVICES INSTALLATION

INDEX

APPENDIX A - GENERAL

1 Regulations

The works must comply with the following current regulations:

1.01 This Specification

1.02 Health and Safety at Work Act

1.03 The Asbestos Regulations

1.04 Local Authorities By-Laws and Regulations

1.05 Water Supply Authority's requirements

1.06 Electricity Supply Authority's requirements

1.07 Gas Supply Authority's requirements

1.08 Fire Officers' Committee Rules

1.09 Any other Special Licensing Authority's requirements

1.10 Appropriate British Standards and Codes of Practice

1.11 Regulations for Electrical Installations

1.12 Gas Safety Regulations

2 Suitability

Use materials and products which:-

2.01 are suitable for the services and conditions of use normally expected to apply after the installation is completed.

2.01 are able to withstand the testing and commissioning conditions specified.

2.03 do not suffer deterioration at the maximum temperature and under the specified conditions of use.

2.04 are capable of being applied to any of the base surfaces without causing damage or deterioration of the base.

2.05 are not a fire hazard or evolve dense or toxic fumes if subjected to excessive heat such as in a fire.

2.06 when of similar type are made by the same manufacturer throughout.

2.07 are BS Kitemarked wherever possible.

2.08 are in accordance with BS 5750 - Quality Assurance Scheme, wherever possible.

3 Handling and Storage

Deliver, off load, store and transport about the works all materials and products in a manner recommended by their manufacturers.

Provide adequate safe and secure covered storage and protection for all materials and products.

Store pipework and similar products on purpose-made racks and adequately support to prevent bending and distortion.

Seal ends of pipework and similar products with purpose made caps and plugs.

Protect all threads with purpose made caps and plugs.

Protect electrical cables from physical damage and seal ends.

Where materials and products cannot be stored in dry buildings, raise them clear of the ground and adequately support, protect and cover to prevent any damage.

Adequately coat materials and products to prevent damage by oxidation or chemical action; maintain this coating until ready for final finishing.

4 Samples

When requested submit samples of materials, products proposed and workmanship completed for examination, testing and approval.

When requested embody in the works any such samples which have been approved.

Where samples are not available submit for approval such detailed drawings as requested.

5 Fixings

Firmly fix all building services components and equipment contained within this Specification.

Use plastic plugs, ensuring screws and plugs are properly embedded when screw fixing to solid brickwork, blockwork or concrete.

Use anchors which tighten under load when bolt fixing to solid brickwork, blockwork or concrete.

Use bolts of sufficient length, a suitable spreader plate under the head, and a nut and washer when through-wall fixing.

Use self tapping screws when fixing to sheet metal, except in air ductlines.

Use clamps and adaptors of 'Lindaptor' pattern, and installed in accordance with the manufacturer's instructions when bolt fixing to structural steelwork.

Do not cut holes in or weld to structural steelwork.

Generally use black japanned screws; roundhead type for radiator brackets and similar bracket type arrangements. Use brass screws on external fixings.

6 Metal Protection

The Contractor shall prepare and treat, including painting, all parts of machinery and pipework supplied under this Contact.

The Contractor is to take due care to screens and protect all works whether complete or in course of completion from the ingress of dust or mastine.

Pipework, fittings, valves, plant and equipment which is unduly marked by tools or damaged or distorted by any cause shall be rejected by the Engineer and replaced by the Contractor at his own expense.

All ferrous metals included in this Contract, e.g. pipes, supports, pumps, etc. shall be given one priming coat of paint prior to delivery or during erection as applicable to prevent formation of rust. After erection all ferrous metals not insulated shall be given on coat of heat resistant paint. Rusted pipework will not be accepted and the Contractor shall clean and paint or remove should the situation warrant any such pipework or fittings at his own expense.

Where final finishes are provided at the maker's works, all such finishes shall be of an approved material, process and colour, and the Contractor shall take all precautions to avoid damage to finishes.

Pipework and fittings shall be stored in a manner approved by the Engineer. Pipework improperly stored and subject to dirt ingress will be removed from site and replaced at the Contractor's expense at the discretion of the Engineer.

Where pipework is temporarily terminated at any point, suitable stop ends shall be provided to prevent dirt ingress. Failure to comply may result in the offending pipework being removed from site and replaced at the Contractor's expense. This at the discretion of the Engineer.

7 Guards and Lubrication

The Contractor shall provide for all tools, guards and lubrication for the Mechanical Installation as specified hereafter.

All moving parts shall be complete with wire mesh guards securely fixed to prevent accidental contact.

The Contractor shall ensure that all grease lubricators have been filled and grease gun applied to all nipples prior to starting up the plant.

The lubrication terminals and connections shall be of common size and type as far as is practicable.

APPENDIX B - STEAM AND CONDENSATE INSTALLATIONS

1 General

This general specification shall be read in conjunction with and shall form part of the foregoing particular specification relative to the section. All requirements contained herein shall be observed as far as these are applicable, unless these requirements are in conflict with those of the particular specification in which case the particular specification shall hold.

2 Steam Pipework and Fittings

Steam piping shall be heavy quality mild steel welded tube to B.S. 1387 1957, of even bore throughout and free from all defects.

Fittings for screwed and socketed pipework shall be wrought iron or steel to B.S. 1740/1951. Fittings for butt welded pipework shall be heavy quality to B.S. 1965/1953. Flanges shall be in accordance with the appropriate table of B.S. 10.

Steam pipework in the boilerhouse and plantroom up to and including 25 mm diameter and elsewhere up to and including 40 mm diameter shall be constructed with welded screwed and socketed or butt welded joints. Pipework up to these sizes shall be provided with g.m. spherical seated unions. Pipework above these diameters shall be fitted with steel flanges, screwed on and welded and sufficient flanges shall be provided to facilitate dismantling. Screwed joints shall be made with approved jointing compound, and flanged joints shall be made with corrugated brass Taylor's rings or approved jointing material.

No joint shall be constructed within the thickness of walls or floors and where pipes pass through walls or floors a steel sleeve is to be provided at least one size larger than that of the pipe. Where pipes pass through walls, floors or ceiling, sleeves shall be finished on either side with chromium plated cast brass plates securely anchored with c.p. brass screws.

Mains, generally, shall follow the lines of the building and vertical pipes shall be installed parallel with adjacent structural surfaces and all pipework shall be neat and symmetrical. Bends shall consist of either standard fittings or be purpose fire made to a centre line radius not less than three times the bore of the pipe and elbows may not be used. The clearance between insulated pipework and nearby structural surfaces shall be at least 40 mm; the clearance from pipe flanges shall be at least 25 mm and a minimum space of 150 mm is required between pipework and all electrical metalwork.

Pipes rising vertically shall be adequately supported to prevent the weight being carried on branches. Bushings on fittings will not be allowed and reductions in pipe size may only be carried out with reducing sockets, (weld fabricated reducing pieces or tapers will be allowed subject to approval). Sockets or tapers on runs of horizontal pipe shall be eccentric type. Gas welding shall be in accordance with B.S. 2640 and the recommendations issued by the Association of Heating, Ventilating, and Domestic Engineering Employers, and electric welding shall be in accordance with the recommendation of the British Welding Research Association.

Welders employed on this sub-contract shall be in possession of a current certificate of competency issued by the Heating, Ventilation and Domestic Engineers National Joint Industrial Council.

Pipe threads shall be full and conform to B.S. 21. Where pipes are cut to length the ends shall be reamed to restore the full bore and on completion of the work the Engineer may require the pipes to be cut in three places to ascertain if the reaming has been done. If the pipes are satisfactory the Sub-Contractor shall be paid for the cutting work and re-jointing, but if they are unsatisfactory the Sub-Contractor will be required at his own cost to remove, ream and refix the whole or any part of the pipework at the discretion of the Engineer. Pipe ends left disconnected during the progress of the works shall be properly capped with purpose made plugs and caps and temporary toppers of paper, etc., shall not be used.

Welded pitcher tees shall be used for branches or connections to convectors etc. and square tees used only at air venting or drain points. Branches, generally, shall sweep in the direction of flow.

Heavily tool marked piping and fittings shall be replaced by new material. Provision shall be made for movement due to expansion either by loops, special expansion joints or bellows where described, or by changes in the direction of the pipework.

3 **Condensate Pipework and Fittings**

Condensate pipework shall be installed between the steam traps or condensate pumping sets and the condensate tank, etc., and consist of copper tube to B.S. 2871 Part 2, Table 5, with fittings to B.S. 864 and flanges to B.S. 10 (Table 'D').

Condensate pipework in the boilerhouse and plantrooms up to and including 25 mm diameter and elsewhere up to and including 40 mm diameter shall be constructed with compression or capillary joints. Pipework above these diameters shall be flanged. Flanges shall be bronze welded in accordance with B.S. 1724 and jointed with approved compound or gaskets to B.S. 1737. Sufficient union connectors and flanges shall be provided to facilitate dismantling.

Condensate pipework and fittings shall generally be similar to those described in Clause 2. except that wall Sleeves shall consist of copper and in all cases where copper pipe connections are made to ferrous materials, special purpose adaptors shall be used as a protection against electrolytic action.

4 **Blow-Down Pipework**

Blow-down pipework shall be heavy quality galvanised mild steel tubing constructed with flanged joints and provided with flanged non-return valves where indicated.

5 **Drain Pipework**

Tundishes for drains (other than those supplied on packaged boilers) shall be 200 mm diameter constructed of 18 s.w.g. copper with 40 mm parallel cylindrical portion at the top and galvanised wire reinforced edge. Tundishes shall be connected to 225 mm 'U' tube water seal and thence via heavy quality galvanised m.s. tubing to the common drain pipe.

The main common drain shall be installed in the boilerhouse duct system and consist of heavy quality galvanised m.s. pipe with flanged joints. Include for connecting between the boiler common drain points and the common drain and for fitting a check valve before the point of discharge into blow-down pit.

6 **'Puddle' Flanges**

Provide and fit 'puddle' flanges for each pipe that passes through wall structure at blow down pit. The 'puddle' flanges shall consist of a mild steel sleeve pipe of suitable length for wall thickness of blow-down sump, securely anchored in wall by means of external welded flanges. The sleeve pipe shall be at least 25 mm larger in diameter than the pipe which has to pass through to ensure adequate clearance for at least eight coils of asbestos rope packing. Rectangular galvanised m.s. closure plates manufactured in two halves shall be fitted around each pipe on either side of the wall to retain the packing. The plates shall be secured with bolts to the wall and the Sub-Contractor shall provide the bolts for building-in and hand to the Contractor.

7 **Exhausts**

All safety valves and vapour vents shall be provided with a heavy quality galvanised iron pipe carried to outside the building and then fitted with a suitable galvanised m.s. exhaust head. A 15 mm drain shall be carried from the bottom of each pipe at the point of connection to safety valve and be taken to discharge into the common drain via a convenient tundish. Similarly a drain shall be connected to the exhaust head and be carried to a nearby gulley trap or other suitable point.

8 **Pipe Supports**

Pipework in boilerhouse, plantrooms, and generally shall be carried on approved rollers and chairs complete with suitable support brackets, or by means of w.i. hangers with universal joint or rollers, to permit of unmaintained expansion.

Pipework in floor ducts, etc., shall be carried on roller and chair support complete with necessary brackets and channel iron bearers all securely anchored to the structure of the building.

Piping in ducts, etc., shall be spaced so that there is access to any pipe without disturbing the others. Allowance must be made for pipe movement and to counteract the tendency of any pipe to lift off its bracket or rollers. Where a hanger is common to more than one pipe, provision shall be made for unequal movement of the pipes. Where pipes are supported from structural steelwork the brackets or hangers must only be attached by means of a proper girder clips. Details of all supporting brackets and other relevant details shall be submitted for approval before being fabricated and pipes shall be supported at intervals not greater than that shown in table '20', British Standard Code of Practice C.P. 341, 300/307.

Pipework generally, shall be graded to fall with a gradient of 1 in 500.

Steel pipework shall be carried on cast iron rollers. Copper pipework shall be carried on cast brass rollers.

Table 20 C.P. 341 300 - 307 1956

Intervals between pipe supports

(a) Wrought iron, mild steel, and heavy gauge copper pipes.

(b) Light gauge copper pipes.

Diameter of Pipe	Intervals for Vertical Runs (metres)		Interval for horizontal Runs (metres)	
	(a)	(b)	(a)	(b)
15 mm	2.4	1.8	1.8	1.2
20 mm	3.0	2.4	2.4	1.8
25 mm	3.0	2.4	2.4	1.8
32 mm	3.0	3.0	2.7	2.4
40 mm	3.6	3.0	3.0	2.4
50 mm	3.6	3.6	3.0	2.7
65 mm	5.0	3.6	3.0	3.0
80 mm	5.0	3.6	3.6	3.0
100mm and above	5.0	3.6	3.7	3.0

9 Expansion Units

Expansion units may be of the loop or bellows type, as indicated on drawing.

9.01 Horseshoe expansion loops shall be flanged type with flanges spaced and drilled to the appropriate table of B.S. 10.

Purpose-made expansion loops shall be made in the same quality and diameter of pipe as that indicated for the adjacent piping. Loops shall be machine made or forged from a single length of pipe and joints in a loop will not be permitted. Guides shall be provided and fixed close to the expansion loop, on both sides, so that all transverse movement will be eliminated and whenever else required.

9.02 Bellows type units shall be of the stainless steel bellows type and loose guides shall be fitted on each side of each expansion unit to maintain pipe alignment, as recommended by manufacturers.

Steel expansion loops shall consist of heavy quality mild steel welded tube to B.S. 1387, and pipe guides shall be of mild steel.

Copper expansion loops shall consist of copper tubing to B.S. 1386, and pipe guides shall be of copper or brass.

In all cases expansion loops and bellows shall be installed so as to be expanded or contracted for a distance equal to half the cold draw.

10 Pipe Anchors

Pipe anchors shall be provided where indicated on drawings, and consist of half-lap brackets welded to the pipe and securely attached to the structure of the building. Details of the anchor brackets shall be submitted to the Engineer for approval, before being manufactured.

Anchors for steel pipework shall consist of mild steel, and those for copper pipework of heavy strip copper.

11 Drain and Relay Points

Drain and relay points in steam lines shall be installed where indicated on drawing and consist of tee junction riser with plugged dirt pocket, and steam trapping set.

12 Steam Trapping Sets

Steam trapping sets shall consist of full bore dirt pocket at least 225 mm long with screwed plug, steam valve, strainer, steam trap, sight glass, non-return valve, gate valve and gunmetal pipe unions, as required. W.I. nipples shall be used in trapping assemblies up to the inlet of steam traps and brass nipples thereafter.

13 Strainers

An approved type strainer with stainless steel or gunmetal element shall be fitted in the steam line in advance of all pressure reducing valves, thermostatic valve, steam traps, etc., and wherever else indicated on drawings.

14 Steam Traps

Steam traps shall be approved thermostatic or float/thermostat type, as required, for use at drain points on steam lines and with convectors, unit heaters, etc.

15 Sight Glasses

Sight glasses shall be fitted throughout the installation except where excluded on drawings.

16 **Automatic Air Vents**

Automatic air vents shall be installed at terminal points of steam mains or on apparatus, whenever shown on drawing. Each air vent shall be provided with a valve for isolation purposes and 15 mm copper drain to a nearby convenient point at low level.

17 **Pressure Gauges**

Pressure gauges shall be 150 mm diameter dial brass cased type, complete with syphon and cock. The dial shall indicate pressure in bar, be calibrated to twice the working pressure and be fitted with black indicating pointer and red line to indicate normal working pressure. Pressure gauges to be incorporated in a control panel shall be flush mounting type.

18 **Steam Valves**

Steam valves shall be provided whenever shown on drawings or described in the specification. They shall be of bronze or cast steel (if required) and suitable for the working pressures stated. Inside the boilerhouse and plantrooms all valves over 20 mm diameter shall be flanged; outside the boilerhouse and plantrooms valves shall be as follows:

18.01 Sizes up to and including 40 mm diameter to be screwed type.

18.02 Sizes above 40 mm diameter to be flanged type.

19 **Condensate Valves**

Condensate valves shall be provided wherever shown on the drawings or described in the specification. They shall be of bronze and inside the boilerhouse and plantrooms all valves over 25 mm diameter shall be flanged; outside the boilerhouse and plantrooms valves shall be as follows:

19.01 Sizes up to and including 50 mm diameter to be g.m. screwed gate valves.

19.02 Sizes above 50 mm diameter to be g.m. fullway flanged gate valves.

20 **Pipeline Drain Valves**

15 mm pipeline drain valves shall be provided where indicated on drawing or wherever else required to provide effective means of draining the system.

21 **Non-Return Valves**

Non-return valves for condensate shall be approved gunmetal swing check type.

Non-return valves for steam shall be approved gunmetal globe check type.

22 **Pressure Reducing Valves**

Pressure reducing valves shall be approved bronze or iron flanged type suitable for passing the volume of steam at inlet and outlet pressures stated on drawing.

23 **Pressure Reducing Set**

A pressure reducing set shall consist of steam stop valve, strainer, pressure reducing valve, safety valve, pressure gauge, thermometer and any necessary taper pieces. A reducing set shall always be preceded by a drain point in the steam line, or installed in such a way that the line thermometers shall be mounted so as to be easily read from floor level.

24 **Condensate Pumping Set**

Condensate pumping set shall consist of a receiver and two pumps. The pumps shall be connected to a common discharge and be equipped with isolating and check valves so that one pump is in service and the other standby alternately. When called for on drawing each set shall be provided with a flow counter or meter, as appropriate. The motors shall be of the totally enclosed, three phase type complete with end drip shield, if required. Each pump shall be provided with a contactor starter with overloads and non-volt protection, and will respond to float switch control. Starters shall be provided with 230 volt coil and will be erected under another contract.

25 **Two Port 'ON-OFF' Valve**

The two port valve shall be motorised 'on-off' type with tight shut-off in closed position, and shall be supplied complete with control box suitable for working in conjunction with a room thermostat, time switch, or other similar controller.

26 **Modulating Two-Port Valve**

The modulating two-port valve shall be motorised type supplied complete with control box suitable for working in conjunction with room thermostat, time switch, or other similar controller.

27 **Steam Thermostatic Valve**

The steam thermostatic valve shall be approved liquid expansion type and shall be installed as shown on the drawing, complete with strainer, isolating valves and valved by-pass. The thermostat shall be suitable for the operating temperature stated with variation of $30^{O}C$.

28 **Testing**

After the erection of equipment and pipework is generally complete but before any insulation work is done, the systems shall be tested in the presence of the Engineer (or his representative).

The Sub-Contractor shall supply all materials, test instruments, water pumps and labour, etc., required for testing, with the exception of fuel oil which will be supplied free of cost. He shall notify the Engineer as to when the systems are ready for testing and shall arrange for these to be carried out at a mutually suitable time.

Fill the systems with water, temporarily seal outlets, eliminate air locks and impose hydraulic test pressures on the systems (excluding safety valves) to the limits stated on the drawings. Rectify any defects and maintain the pressure until all parts remain dry for at least 2 hours.

After completion of hydraulic tests, remove temporary seals, place systems in normal working order and operate installations to attain design conditions of temperature and pressure. Rectify any defects, regulate the various circuits and after the installations have been passed as satisfactory by the Engineer, carry out insulation work and run the plant for a sufficient time to complete drying out. In any case the Sub-Contractor will be required to operate the plant under normal working conditions thereafter for a total of 48 hours during normal daytime hours of employment.

29 **Commissioning**

The Sub-Contractor shall be required during the test period, to give instruction to the boilerhouse attendants such that they become fully conversant with the equipment and adept at its proper control.

At the end of this period, the Sub-Contractor shall be required to give a demonstration of the operation of all control equipment, carry out a performance test at which figures not less than those specified shall be achieved, and make a circulation test over a period of at least four hours in accordance with C.I.B.S.E procedure, except that temperature readings on individual heating units will not usually be required.

Any work not satisfactorily completed shall be subject to a further demonstration when complete.

For the purpose of commissioning and demonstration the Sub-Contractor shall arrange for the attendance of staff, including those of control and burner manufacturer, etc., as necessary.

Should it be necessary and ordered by the Engineer in writing to continue the tests beyond the period stated, the Sub-Contractors shall be paid the rates of wages generally accepted for Fitters and Labourers for the District, together with an addition of the percentage shown on Daywork Schedule submitted with tender to cover profit, superintendance, etc. Time sheets in respect of such wages shall be certified by the Clerk of Works or other authorised persons.

30 **Instruction Manuals etc.**

The Sub-Contractor shall provide a comprehensive set of manufacturers instruction manuals and maintenance sheets for boilers, pumps, oil burning equipment and other specialised apparatus and shall in addition provide wiring diagrams, commission the plant and instruct the operating staff. Such instruction manuals and maintenance sheets shall be handed to the Engineer.

In the case of control panels and control consoles, full wiring diagrams shall be supplied and, if feasible, be mounted inside the panel access doors and be suitably protected with a transparent plastic sheet. If there is insufficient room in the panels, the diagrams shall be placed in a glazed hardwood frame and be secured to the boilerhouse wall in a convenient position.

31 **Labels**

Throughout the entire installation labels shall be fixed to all control and isolating valves to indicate the function of the valve and the line served. Such labels shall be affixed with strong copper wire, and consist of 14 s.w.g. brass sheet measuring 80 mm x 50 mm with the size and duty of the valve clearly embossed thereon in 6 mm lettering afterwards infilled with black paint.

In addition suitable labels consisting of white laminated plastic with black lettering shall be provided and affixed by means of brass screws or other secure means (adhesives will not be used), sufficient to fully identify each instrument, indicator, switch, or other piece of apparatus on the installation.

32 Tools and Tool Racks

Provide two keys for each size and type of key-operated valve, vent air cock, etc., fitted in the boilerhouse, plantroom, throughout the installation. Provide one set of steel spanners to suit all nuts on the boilerhouse and plantroom apparatus and also a claw hammer, snub-nosed pliers and medium sized screwdriver.

Provide and fix to the wall of the boilerhouse or plantrooms, in approved position 25 mm thick varnished bevelled hardwood tool rack arranged with clips, hooks and bars, etc., as required to accommodate tools and keys.

Provide one set of furnace and flue cleaning tools and provide and fix a suitable rack for these on the boilerhouse or plantroom wall, in approved position.

APPENDIX C - L.P.H.W. HEATING INSTALLATIONS

1 General

This general specification shall be read in conjunction with and shall form part of the foregoing particular specification relative to the section. All requirements contained herein shall be observed as far a these are applicable, unless these requirements are in conflict with those of the particular specification in which case the particular specification shall hold.

2 Pipework Preparation and Installation

All pipework shall be delivered to the site in manufacturers random lengths (6 metres). Straight runs shall incorporate full lengths and in no case will 'piecing' of shortcuttings be permitted.

All pipes cut to length prior to screwing or welding shall be reamed or filed to restore the full bore and remove burrs and sharp edges before fitting. The Consulting Engineers shall reserve the right to instruct the Contractor to remove selected sections of pipework to check that this has been done, and should it be found that reaming has not been satisfactorily carried out, or that the pipe bore is in any way restricted, the Contractor shall be required to remove these and all other similar pipes adjacent until satisfactory conditions are found. In this case the Contractor shall at his own expense carry out all removal, reaming and reinstatement work involved.

Care shall be taken during installation to prevent the ingress of screwing swarf, oil jointing paste or other foreign matter to the pipe bore. Caps shall be used to seal pipe ends temporarily left open during erection.

Pipework shall be graded to promote the travel of air to vent points.

Pipe threads on screwed pipework shall be to B.S.S. 21 : 1938 taper. Jointing shall be non-toxic oil based pipe jointing paste used with the minimum of hemp or flax. All surplus jointing shall be cleaned off threads and fittings before it hardens.

All pipework shall be left free from burrs, excessive tool marks, distortion of section or other defects.

3 Assembly

In boilerhouses, plant and calorifier rooms and similar locations, the pipework shall form a welded assembly, at pipe sizes 50mm and above. A screwed assembly shall be used up to and including 40mm.

In unoccupied spaces (e.g. ducts, roofspaces, etc.) the pipework shall be welded with sufficient unions or flanges to permit the disconnection of sections.

In occupied areas of the building where pipework is exposed to view, the main consideration being one of neatness, the pipework shall be screwed and assembled using C.I. malleable fittings. Unions shall be incorporated in an inconspicuous manner to facilitate the disconnection of sections of the pipework.

4 Pipework

4.01 L.P.H.W. Heating

Pipework shall be fabricated from black mild steel tube to B.S.S. 1387 : 1985 and subsequent amendments, medium grade.

4.02 Cold Feeds, Vents, Overflows & Air Pipes

Pipework shall be fabricated from galvanised mild steel tube to B.S.S. 1387 : 1985 and subsequent amendments, medium grade.

4.03 **Oil**

Pipework including fill, vent and sludge pipes, shall be fabricated from black mild steel tube to B.S.S. 1387 : 1985 and subsequent amendments, medium grade.

5 Fittings

5.01 L.P.H.W. Heating

Where the specification calls for a welded assembly solid drawn seamless welding fitting to B.S.S. 1965 : 1963 and subsequent amendments, shall be used having a wall thickness equal to that of the pipework.

Welding fittings shall be used in welded assemblies for:-

Short radius bends (up to 180^{o})

Swept branches

Eccentric reducers

Concentric reducers

Blank end caps

All branches shall be swept except these at air vents. Bends to non standard angles shall be made by radially cutting a standard bend to the required angle.

Where the specification calls for a screwed assembly, malleable cast iron beaded fittings to B.S.S. 1256 : 1952 shall be used. Sweep tees shall be used at all branches including radiator connections and where standard reducing fittings are available, the use of bushings will not be permitted.

Square tees shall be used for air venting and the drilling of fittings for the insertion of air cocks etc. will not be permitted.

Unions shall be cast iron malleable pattern having a bronze faced conical seat.

5.02 Cold Feeds, Vents, Overflow and Air Pipes

Fittings shall be galvanised malleable cast iron headed fittings to B.S. 143 and 1256 : 1986 and all subsequent amendments. All the requirements of Clause 5.1, (ii) for L.P.H.W. heating shall apply.

5.03 Oil

Fittings shall be solid drawn seamless welding fitting to B.S. 1965, having a wall thickness equal to that of the pipework. The requirements of Paragraph 5.1 (i) for L.P.H.W. heating shall apply.

6 **Flanges**

Flanges shall be provided on pipework in the locations previously specified and shall also be used to make connections to items of plant.

Flanges shall be to B.S. 10 table 'D' faced and drilled. Black flanges to be used on L.P.H.W. galvanised flanges on cold feeds, vents, overflows and air pipes.

The jointing of flanges shall be by suitable jointing material cut to the flange size and having both faces covered with 'BOSS' white, or equal, jointing paste.

7 **Sleeves and Plates**

At all points where pipes pass through walls, floors, partitions or ceilings, a mild steel sleeve shall be provided for building in by the Main Contractor. This sleeve shall be one size larger than the pipe and shall terminate flush with the finished surface. It shall permit free movement of the pipe and shall be faced by two chromium plated brass plates which shall be securely fixed to the sleeve or the building structure by chrome headed brass screws.

The annular space between all sleeves and pipework shall be packed with 6 mm fibrous cord at either end.

8 **Pipe Supports**

The whole of the pipework assembly shall be securely bracketed or hung, the type of support used being determined by consideration of size, weight, location and neatness. The following requirements shall be taken as a general guide.

8.01 **Pipework in Horizontal Ducts**

(a) On rollers and chairs supported on mild steel joists or angles built into the sides of the duct.

(b) On stirrup roller brackets suspended from mild steel joists or angles built into the sides of the duct.

(c) In crawl ducts either method of support may be used, but the mild steel joists or angles shall not be taken across the width of the duct but shall be arranged so that an unrestricted passage is available in the crawl duct at all times.

8.02 **Pipework in Vertical Ducts**

For pipes up to and including 25mm bore Paragraph 5.03 (a) shall apply.

For pipes 32mm and above, pipes shall be supported by M.S. brackets of bolted half lap construction fixed to suitably sized channel iron baseplates.

8.03 **Exposed Pipework at High Level**

This shall be supported according to conditions as follows:-

(a) On small bore pipe runs in offices, corridors, etc. Pipes shall be supported by building-in, screw-to-wood, or wall plugged brackets of either munzing of S.B. pattern.

(b) On single or multiple pipe runs along walls in factory or non-occupied areas, wall mounted roller brackets shall be used.

(c) On single or multiple pipe runs in factory or non-occupied areas where there are no adjacent walls, roller brackets on roof steelwork or suspended stirrup roller brackets shall be used.

8.04 **Exposed Pipework at Floor Level**

This shall be supported by building-in, screw-to-wood or wall plugged brackets to either munzing or S.B. pattern. Long shank S.B. hooks shall be used where these can be accommodated. In cases where pipe runs must be supported at excessive horizontal distances from the wall, purpose made M.S. brackets of bolted lap construction shall be employed.

Care shall be taken in the location of brackets to ensure that no resistance is offered to expansion movements particularly at points adjacent to changes of direction.

8.05 **Spacing of Brackets**

Pipework shall be supported at intervals not greater than those listed below:-

Up to 20 mm bore	-	1.8m intervals
25 mm and 35 mm bore	-	2.4m intervals
40 mm up to 80 mm bore	-	3.0m intervals
100 mm and above	-	3.6m intervals

In the case of multiple pipe runs supported on a common assembly the spacing of brackets shall be determined by the diameter of the smallest pipe.

9 **Valves**

All valves - 50 mm bore and above - in boilerhouses, plant and calorifier rooms shall be flanged B.S.T. 'D'.

In other locations all valves 65 mm bore and above shall be flanged B.S.T. 'D'. Valves 50 mm bore and under shall be screwed female B.S.P. thread (taper).
Flanged valves 50 mm bore and above shall be C.I. standard medium pattern fullway sluice valves with inside screw and suitable for working pressure of 6.9 bar. They shall be of the following manufacture.

Hattersley	Fig No. 549
Crane	Fig. No. F52

Screwed valves 50 mm bore and under shall be gunmetal fullway pattern as follows:-

Hattersley	Fig. No. 30 DZR
Crane	Fig. No. D159
Peglers	Fig. No. 1070/125

On circuits and sub-circuits flow valves shall be fitted with a composition handwheel and those on the return with a lockshield.

Radiator Valves

Each radiator shall be provided with a wheel valve on the flow connection and a lockshield valve on the return connection. Valves shall be straight or angle pattern to suit the application and shall be polished chromium plated easy clean type as follows:-

Straight Pattern

Hattersley	Fig. No. 2407
Crane	Fig. No. D621/D623

Angle Pattern

Hattersley	Fig. No. 2386
Crane	Fig. No. D601/D603

Other heating units, e.g. unit heaters, mechanical and natural convectors, panels, baseboard heating, skirting strip, etc. shall be provided with flow and return control valves. In occupied and exposed locations valves shall be similar to those specified for radiators.

Where regulating valves are specifically called for in the particular specification or on the drawings, these shall be:-

Occupied Exposed Locations

Hattersley	Fig. No. P 373 M.U.E.C. P 394 E.C.

or other equal and approved.

Completely Concealed Locations

Hattersley	Fig. No. P373 or P 393

or other equal and approved.

Embedded panel valves shall be gunmetal 'Y' type regulating valves with screwed ends, rising stems and freely rotating disc as Hattersley Fig. P367 or Crane D.611/D.613. Lockshield Valves shall be fitted on both flow and return with a drain cock on the panel side of the return valve.

10 **Drain and Cold Feed Cocks**

In addition to the standard boiler and heat exchanger draw-off cocks, each low point on valve circuits and sub-circuits throughout the system shall be provided with a drain cock.

These cocks shall be 15 mm bore gunmetal gland type with hose union and shall be of the following manufacture:-

Hattersley	Fig. No. 81 H.U.

or other equal and approved.

Each cold feed line shall be provided with two gunmetal gland cocks, one located at the feed tank, the other at the point of entry to the system. These cocks shall be of the following manufacture:-

Hattersley	Fig. No. 81
Crane	Fig. No. D. 320
Pegler	Fig. No. 1090/100

or other equal and approved.

11 Expansion

Thermal expansion in L.P.H.W. heating pipe lines shall be taken up by expansion loops, expansion joints or changes of direction.

11.01 Expansion Loops

These shall be either factory made or fabricated on site to suit the application.

Purpose made loops shall be of welded construction but welds will not be permitted other than at welding fittings.

Cold draw shall be applied to all loops by the insertion of a temporary struct which shall spring the loop outwards to a distance approximately half of the expected expansion movement (which may be taken as 1.0 mm per metre). After all joints have been made and anchors fitted, these struts shall be removed.

11.02 Expansion Joints

Expansion joints shall be M.S. flanged bellows type with stainless steel bellows and M.S. protection sleeves and shall be suitable for a working pressure of 3.4 bar gauge. Flanges shall be in accordance with B.S.T. 'D'.

Care shall be taken when installing expansion joints to obviate 'out of line displacement', and the pipe line shall be securely supported and guided on both sides immediately adjacent to the expansion joint.

12 Anchors and Guides

Pipe anchors shall be installed where indicated on the drawings and elsewhere, where necessary to establish static points between expansion loops and joints.

Anchors shall be purpose made in each instance to suit the application. They shall be fabricated from mild steel and shall be complete with bands, bolts, struts and other components necessary to provide a rigid anchor. Where necessary M.S. lugs shall be welded on the pipework to augment the anchor strap.

Guides shall be installed where indicated on the drawings and on either side of expansion joints, and loops to maintain free guided movement of the pipework.

Guides shall be installed at a distance not exceeding 300 mm from the flange of the expansion joint.

Guides shall be purpose made in each instance to suit the application and in every case shall incorporate a roller both on the top and bottom of the pipe.

Where anchors or guides are not detailed on the drawings, the Contractor shall, before fabrication, submit to the Consulting Engineer for his approval a detailed drawing showing the proposed construction of each unit.

13 **Vent Pipes**

Each boiler and calorifier shall be provided with an open vent pipe. These pipes shall be carried where possible with a continuous rising gradient and shall terminate above the level of the feed and expansion tank to a height sufficient to overcome the head generated by the circulating pumps.

In cases where a continuous rising gradient cannot be accommodated automatic air eliminators shall be fitted to vent local high points. Air eliminators shall be as specified in Clause 14.

14 **Air Venting**

All local high points on pipe lines shall be vented by automatic air eliminators.

Air Eliminators shall be of brass construction and of the float operated pattern and of the following manufacture:-

Messrs. Spirax Sarco	Type O.P.
Messrs. Winns	Type B.

Each eliminator shall be installed with a 15 mm gunmetal fullway gate valve on the inlet and a light gauge copper drain pipe shall be taken from the outlet and terminated in the open or at an agreed point within the building.

Radiators, convectors and other heating units shall be vented by integral air cocks except in cases where they are self-venting into the mains.

15 **Radiators**

Radiators shall be either of mild steel or cast iron construction and shall be complete with valves, brackets and air vents. Details of the radiators to be used are incorporated in a separate schedule to which the following general requirements shall apply.

Cast Iron Pattern
These shall have machined joint faces right and left hand screwed nipples and paper jointing gaskets and the return end sections shall incorporate a needle valve air release.

Mild Steel Type
These shall be of welded or brazed construction and shall form a rigid uniform assembly. Radiators having a marked degree of distortion or which vary excessively from the catalogue dimensions will not be accepted.

16 **Radiator Brackets**

Floor mounted radiators shall be provided with feet either cast integral with the end sections or of the neatly purpose made removable type.

Wall mounted radiators shall be supported on adjustable brackets rawlbolted to the wall. These brackets shall be capable of vertical and horizontal adjustment.

Cast iron radiators shall be further steadied by the provision of stirrup type adjustable holdfasts located between sections approximately half way between top and bottom.

As a general guide supports shall be provided as follows:-

Bottom Brackets

Radiators up to 1.2m long	-	2 Brackets
Radiators 1.2m to 2.4m	-	3 Brackets
Radiators 2.4m to 3.6m	-	4 Brackets
Over 3.6m long	-	Pro rata

Top Holdfasts

Radiators up to 1.2m long	-	1 Holdfast
Radiators 1.2m to 2.4m	-	2 Holdfasts
Radiators 2.4m to 3.6m	-	3 Holdfasts
Radiators over 3.6m	-	Pro rata

In cases where the above brackets are impracticable as with certain types of steel radiator, the radiator manufacturers special bracket shall be used.

All radiator supports shall be arranged to give a light imperceptible rise to the radiator toward the air vent.

17 **Radiator Shelves**

Radiators installed in locations other than under windows of normal sill height shall be provided with shelves. These shall be of sufficient length and width to fully cover the radiator including the valves. They shall be of glass fibre or steel construction and shall be securely rawlplugged to the wall.

18 **Feed and Expansion Tank**

Each L.P.H.W. plant shall be served by a mild steel galvanised open top tank with loose cover. Each tank shall be constructed in accordance with the requirements of B.S. 417 : Part 2:1987 of Grade 'A' thickness, and shall be located above the highest point of the system which it serves. The size of each tank shall be as detailed in the particular section of the Specification.

All connections shall be in the form of screwed bosses welded on.

A 16 gauge galvanised mild steel loose cover with skirt to cover the tank sides and lifting handles shall be provided for each tank.

Suitable brackets or bearers shall be provided under this Contract.

19 **Ballvalve**

A Portsmouth type ballvalve to B.S. 1212 shall be installed in the tank. This ballvalve shall have an extended arm cranked to maintain a low water level in the tank when the plant is cold.

The provision of a mains water supply to the Ballvalve will be carried out under the plumbing contract.

20 **Boiler and/or Calorifier Mountings and Fittings**

Each boiler and/or calorifier shall be provided with the following mountings and fittings:-

20.01 **Safety Valve**

One gunmetal spring type safety valve complete with cadmium plated spring and padlock. A drain pipe shall be taken from the outlet of each safety valve and terminated 450 mm from floor level clear of all equipment.

20.02 **Altitude Gauge**

One 100 mm diameter brass cased H.M.O.W. pattern altitude gauge graduated in metres head and bar gauge with red normal reading pointer, connection screwed 10 mm male B.S.P. complete with 10 mm female gunmetal cock.

20.03 **Thermometer**

One 100 mm dial vapour pressure rigid stem thermometer calibrated from $0^{o}C$ - $100^{o}c$ complete with separable pocket. Thermometers shall be located so that a true indication of temperature is obtained, and the pocket shall be fitted with a suitable heat conducting grease. They shall be as manufactured by the British Rototherm Co. Ltd., G.H. Zeal Ltd., or British Steam Specialities Ltd. Thermometers shall be either angle or straight pattern to suit the application.

20.04 **Drain Cocks**

Drain (draw off) cocks shall be as described in B.10.

21 Spares and Tools

The following spares and tools shall be provided and handed over to the purchaser or his representative at the time of taking over.

21.01 **Keys**

All key or handle operated equipment including valves and cocks shall be provided with keys or handles, one for each unit except for fullway valves on circuits, where two keys for each size of valve installed shall be provided.

22 Welding

Where a welded assembly is called for the following requirements shall be adhered to:-

Flanges shall be neck and bore welded by the electric metal arc process and pipework 65 mm bore and above may also be electrically welded.

All other pipework and brackets, anchors and hangers shall be welded using the oxy-acetylene process.

Where welding of pipe supports, anchors or brackets to structural steelwork is carried out the Contractor shall be required to protect the adjacent sheeting or glazing against damage. Any damage caused by welding shall be rectified at his own expense.

The Contractor shall provide all plant and equipment necessary and in the case of metal arc welding where no suitable electricity supply is available this shall include suitable portable generator plant.

Where the Contractor is able to come to an agreement to obtain an electrical supply from the Main Contractors temporary supply he shall be responsible for all wiring from the nearest distribution point. He shall also be responsible for compliance with the I.E.E Regulations and the Local Supply Authorities requirements dealing with temporary installations.

22.01 **Oxy-Acetylene Welding**

Oxy-acetylene welding shall comply with the recommendations contained in B.S. 2640 and all subsequent amendments and 'Recommended practice for oxy-acetylene welds in mild steel pipe lines' published by the Association of Heating, Ventilating and Domestic Engineering Employers. All operatives employed on this work shall be in possession of a current valid 'Certificate of Competency' and shall have been employed as a welder on pipework during the six months preceding his employment on this Contract.

Welding shall be carried out by the technique appropriate to the wall thickness bore and location as recommended in the above publication.

22.02 **Electric Metal Arc Welding**

Electric metal arc welding shall comply with the requirements of B.S. 2633 and all subsequent amendments, and shall be carried out by skilled operatives. The Consulting Engineers may at their discretion test the capabilities of any operative engaged on this by requiring him to undergo a number of the standard tests described in B.S. 2645 Part 2. Such tests selected shall be those appropriate to the nature of the particular welding to be carried out under this Contract.

22.03 **Weld Tests**

Pipework, butt welds and welding fittings shall be subjected to the inspection and other tests detailed in 'Recommended practice for oxy-acetylene Welds in mild steel pipelines' published by the Association of Heating, Ventilating and Domestic Engineering Employers. The Heating Contractor shall allow for the replacement of six weld specimens under this Section of the Contract.

23 Testing

All sections of pipework shall be hydraulically tested in sections during erection. This test shall be to a pressure of 6.7 bar gauge or to twice the normal static pressure whichever is the greater and shall be maintained for a period of 2 hours without loss, in the presence of the Consulting Engineers.

All defects which become apparent shall be made good and the test re-applied.

24 Commissioning and Calibration

The Heating Contractor shall on completion of erection and hydraulic testing, commission the plant and operate it for a period of five consecutive days allowing it to cool nightly. During this period all calibration and setting of controls shall be carried out.

The complete system shall be balanced and regulated and to facilitate this the Heating Contractor shall provide where necessary clip-on-thermometers to obtain equal temperature drops through the various circuits.

The Contractor shall provide if required two clockwork themographs to record the temperature in any number of rooms requested by the Consulting Engineer. The graphs obtained shall be dated and numbered for each room and handed over to the Consulting Engineer.

During these tests the Engineer or Caretaker in charge shall be given all necessary instructions in the operation of the plant and the maintenance of same. All instruction books, sheets or cards shall be handed over and a receipt obtained.

On completion of these tests the installation shall be left fully operational and to the satisfaction of the Consulting Engineer.

25 Labels

Control panels shall be comprehensively and uniformly labelled.

Each instrument, switch, indicating light etc., shall be identified by an engraved traffolyte label neatly set screwed by countersunk chromium plated screws. Engraved lettering shall be infilled with black in each instance. The individual panels shall each be provided with a larger identifying label indicating its function.

Boilers, tanks, pump motors, oil contents gauges, thermometers etc., shall be labelled as described for panels.

All valves except boiler isolating valves, isolating valves located adjacent to readily identifiable components and other small valves the purpose of which is self evident shall be provided with labels as described hereunder.

Valve labels shall consist of a circuit White/Black/White Traffolyte disc with centre fixing hole, secured on the valve spindle by the wheel retaining nut and accommodate neatly within the handwheel. Labels shall be engraved indicating the function of each valve.

APPENDIX D - PLUMBING INSTALLATIONS

1 General

This general specification shall be read in conjunction with and shall form part of the following particular specification relative to this section. All the requirements contained herein shall be observed as far as these are applicable unless such requirements are in conflict with those of the particular specification in which case the particular specification shall hold.

The entire installation shall be in accordance with the latest water byelaws. It shall be the responsibility of the installer to ensure that these regulations are met in all respects.

2 Pipework Preparation and Installation

Pipework shall be installed in straight lengths with the minimum of couplings. It shall be neatly installed and shall follow the line of walls both vertically and horizontally and shall be correctly graded to suit the particular service.

Factory made bends and branches shall be used and formed pipework bends will be permitted only in concealed locations. Formed offsets shall be permitted where practicable, the main consideration being that of neatness of appearance. Such bends and sets shall be made using an efficient hydraulic or screw mechanical bender with true formers. Undiminished circular bore must be maintained and no rippling of the throat or undue wastage of the heel or general distortion will be permitted.

All pipes cut to length prior to fitting shall be reamed or filed to restore the full clear bore and any pipework found which fails to meet these requirements will be rejected.

No joints of any kind shall be made within the thickness of walls, floors or ceilings.

External mains water pipework shall be installed at least 760 mm below the finished ground level and shall be laid in such a way that there is no possibility of air being trapped.

All pipework shall be left free from burrs, excessive tool marks, distortion of section or other defects.

3 Pipework

3.01 Internal Hot, Cold and Mains Water Services, Cold Feeds, Vent Pipes and W.C. Overflows

Pipework shall be in solid drawn copper tube to B.S. 2871 Table X, and shall bear the 'Kitemark' of the British Standards Institution.

3.02 Underground Cold Water Services

Underground pipework shall be either medium density blue polyethylene (MPDE) or copper, as specified.

Blue MDPE pipework shall be to B.S. 6572 and Water Industry Specification 04.32.02 up to and including 63mm; for 90mm and above, pipework shall be to Water Industry Specifications 04.32.03 and 04.32.04.

Copper pipework shall be to B.S. 2871 Table Y, with factory applied PVC covering. Copper tube shall bear the 'Kitemark' of the British Standards Institution.

3.03 **Internal Waste Pipes**

Pipework shall be either copper or PVC as specified.

Copper pipes shall be to B.S. 2871 Table Z, and shall bear the 'Kitemark' of the British Standard Institution. Pulled bends shall not be permitted.

PVC pipes shall be to B.S. 5254 and/or 5255.

3.04 **External Waste Pipes**

Pipework shall be in Thinwall solid drawn copper tube to B.S. 2871 Table Z, and shall bear the 'Kitemark' of the British Standards Institution. Pulled Bends shall not be permitted.

3.05 **Soil and Ventilation Pipes**

Pipework shall be in UPVC to B.S. 4514.

3.06 **Tank Overflows**

These shall be in galvanised mild steel tube to B.S. 1387 : 1985 and subsequent amendments, medium grade.

4 Fittings

4.01 **General**

In Clauses 4.02 to 4.05 it shall be understood that approval to use fittings of alternative manufacturers does not give the Contractor permission to 'mix' fittings on exposed pipework. Throughout the premises, matching fittings of one manufacturer only will be acceptable on exposed pipework.

4.02 **Internal HWS, CWS, MWS, CF, OV and WC Overflows**

Only **unleaded** solder shall be used.

Capillary fittings shall be used throughout and shall be in accordance with B.S. 864 : 1983 and all subsequent amendments, as Yorkshire Imperial Metals Ltd., Kay & Co. (Engineers) Ltd., or other equal and approved manufacture.

Where approved for use by the Consulting Engineer, compression fittings shall be in accordance with B.S. 864 : 1983 and all subsequent amendments, and shall be Kontite, Securex, Instantor, or other equal and approved manufacture.

On pipework 80 mm bore and above flanged fittings shall be used.

4.03 **Underground Cold Water Services**

Fittings for Blue MDPE shall be electro-fusion type ; compression type may be used only when the equivalent electro-fusion fitting is not manufactured. Fittings shall comply with the standards quoted in clause C3.2.

Where compression fittings are called for on underground copper mains, these shall be Yorkshire type 'B' manipulative fittings or Konite 'B' gunmetal fittings.

4.04 **Internal Waste Pipes**

Copper fittings shall be capillary type in accordance with B.S. 864 : 1983 and all subsequent amendments, and shall be as Yorkshire, Kay & Co. or other equal and approved manufacture.

P.V.C. fittings shall be push-fit type to B.S. 5254 and/or 5255.

On waste float ends, and where changes of direction occur, cleaning tees with screwed rodding caps shall be used.

4.05 **External Wastes**

Fittings shall be capillary type in accordance with B.S. 864 : 1983 and all subsequent amendments, and shall be as Yorkshire, Kay & Co. or other equal and approved manufacture.

On waste float ends, and where changes of direction occur, cleaning tees with screwed rodding caps shall be used.

4.06 **Soil and Ventilation Pipes**

UPVC fittings shall be push-fit type to B.S. 4514.

Connections to W.C. Pans shall be made with standard W.C. ring seal connectors.

On soil float ends, and where changes of direction occur, cleaning tees with screwed rodding caps shall be used.

Branch fittings shall be used where waste branches connect to soil and ventilation pipes. Solvent bosses shall normally not be permitted and shall only be used in specific instances with the permission of the Consulting Engineer.

4.07 **Tank Overflows**

Fittings shall be galvanised screwed malleable cast iron beaded to B.S. 143 and 1256 : 1986 and all subsequent amendments.

5 **Soil and Waste Connections**

Where soil or waste pipes connect into glazed earthenware or cast iron socketed connections provided by the Building Contractor, the connection and jointing to such outlets shall be included under this Contract.

6 **Flanges**

Flanges shall be used in the locations previously specified, also at flanged valves and for connecting to equipment having flanged connections.

Flanges shall be of brass to B.S. Table 'D' and shall be the Fig. 1 F.D. flanged adaptor as manufactured by Messrs. Yorkshire Imperial Metals Ltd., or other equal and approved.

Flanged joints shall be made using steel bolts, nuts, washers, and 'Taylors' joint rings. All bolts shall be sufficiently long to allow two threads to project beyond the crown of the nut when it is fully tightened up.

7 **Pipe Sleeves and Plates**

In all cases where pipes of any service pass through walls, floors, ceilings, partitions, etc. the pipes shall be enclosed by a copper sleeve. Such sleeves shall be carefully cut to length in order to finish flush with the finished surface.

The ends of sleeves shall be concealed by means of chromium plated wall/floor plates securely fixed to the sleeve or rawlplugged to the structure.

Floor and wall plates shall be of heavy cast brass while ceiling plates shall be of pressed brass.

In the case of all pipework other than that carrying cold water, the annular space between sleeves and pipework shall be packed at either end with 6 mm fibrous cord.

8 **Pipe Supports**

The whole of the pipework system shall be securely supported and bracketed, the brackets on hot water pipework being arranged to permit freedom for expansion and contraction. The type of bracket used shall be determined by consideration of size, weight, location and neatness and the following general requirements shall apply.

Single pipes fitted adjacent to wall and where there are ample changes of direction may be supported on 'school board' type brackets or munzing rings. These shall be of polished cast brass or gunmetal construction as manufactured by Yorkshire Imperial Metals Ltd., Longbottom & Co. (Keighley) or other equal and approved. The use of copper saddle band supports will not be acceptable anywhere on the plumbing installation.

Piping installed beneath steelwork shall generally be supported by hanger brackets from the steelwork and in the case of H.W.S. pipes the bracket shall incorporate a brass roller.

In the case of all copper pipes carried on purpose made brackets a copper sheath shall be used to prevent contact between the pipe and the ferrous metal of the bracket.

Standard brackets used for the support of galvanised piping shall be galvanised.

The spacing of brackets shall be as follows:-

Pipe Diameter	**Copper**	**Steel**
Up to 20 mm bore	1.2m	1.8m
25 mm and 35 mm bore	1.8m	2.4m
40 mm up to 80 mm bore	2.4m	3.0m
100 mm bore and above	3.0m	3.6m

Cast iron soil and vent pipes shall be supported beneath each socket and at intervals not exceeding 2.4m. Brackets shall be standard wrought iron or metal bar band type.

Cast iron underground water mains shall have blocks laid beneath them where necessary to prevent subsidence and shall also be substantially anchored at all changes of direction.

9 **Valves**

All valves 54 mm bore and above in Boilerhouses, plant, calorifier and Tank Rooms shall be flanged B.S.T. 'D'.

In other locations all valves 65 mm bore and above shall be flanged B.S.T. 'D'.

Valves 40 mm bore and under shall be provided with compression ends for copper.

All flanged valves shall be gunmetal fullway gate pattern suitable for a working pressure of 13.5 bar and shall be:-

Hattersley Fig. No. 549E with brass trim

Valves with compression ends 54 mm bore and under shall be gunmetal fullway gate pattern suitable for a working pressure of 13.5 bar and shall be;

Prestex 63 G M

Where isolating valves are located in the ground the Contractor shall provide a surface box for each valve. Surface boxes shall be as manufactured by Broads Manufacturing Co. Ltd., or other equal and approved manufacture and shall have the works 'Stop Valve' cast on the cover.

10 Stopcocks and Valves

In addition to the stopcocks and valves specifically indicated on the Drawings or detailed in the particular specifications, every branch to single or close ranges of draw-off points shall be fitted with a stopcock or valve of the appropriate size.

Stopcocks shall be fitted to mains water pipes and shall be easy clean, lockshield, screw-down pattern with discs suitable for the service on which they are installed. They shall be complete with the capillary or compression tails as appropriate and shall be as manufactured by Yorkshire Copper Works, Kay & Co., or other equal and approved manufacturer.

11 Expansion

Thermal expansion in L.P.H.W. heating pipe lines shall be taken up by expansion loops, expansion joints or changes of direction.

11.01 Expansion Loops

These shall be either factory made or purpose made as required and shall be installed on all hot water pipework where indicated.

Purpose made loops shall be of brazed construction with gunmetal flanged ends to B.S. table 'D8'. Brazing will not be permitted other than at brazing fittings.

Cold draw shall be applied to all loops by the insertion of a temporary strut which shall spring the loop outwards to a distance approximately half of the expected expansion movement (which may be taken at 1.5 mm per metre). After flanged joints have been made and anchors fitted this strut shall be removed.

11.02 Expansion Joints

Expansion joints on hot water service pipework shall be bellows type with stainless steel bellows, copper protection sleeves and gunmetal flanged ends to B.S. Table 'D' and shall be suitable for a working pressure of 3.4 bar gauge.

Care shall be taken when installing expansion joints to obviate 'out of line' movement and the pipeline shall be securely supported and guided on both sides immediately adjacent to the expansion joint.

12 Anchors and Guides

Pipe anchors shall be installed where indicated on the drawings and elsewhere where necessary to establish static points between expansion loops and joints.

Anchors shall be purpose made to suit the application and shall be complete with bands, bolts, struts and other components necessary to provide a rigid anchor. A copper liner shall be incorporated between the band and the pipe and where necessary lugs shall be brazed to the pipework to augment the anchor strap.
Guides shall be installed where indicated on the drawings and on either side of expansion joints and loops to maintain free guided movement of the pipework. At expansion joints, guides shall be installed at a distance not exceeding 300 mm from the flange of the joint.

Guides shall be purpose made to suit the application and in each instance shall incorporate a brass roller both on the top and bottom of the pipe.

Where anchors or guides are not detailed on the drawings, the Contractor shall before fabrication submit to the Consulting Engineer for his approval a detailed drawing showing the proposed construction of each unit.

13 Open Vent Pipes

Each cylinder or storage calorifier shall be provided with an open vent pipe. These pipes shall be carried with a continuous rising gradient and shall terminate above the level of the cold water storage tank.

In cases where a continuous rising gradient cannot be accommodated automatic air eliminators shall be fitted to vent local high points.

14 Air Eliminators

Air eliminators shall be of brass construction and of the float operated pattern and of the following manufacture:-

Spirax Sarco	Type O.P.
Messrs. Winns	Type B.

Each air eliminator shall be installed with a 15 mm gunmetal fullway gate valve on the inlet and a light gauge copper drain pipe shall be taken from the outlet and terminated in the open or an agreed point within the building.

15 Calorifier and/or Cylinder Mountings and Fittings

Each calorifier and/or cylinder shall be installed complete with the following mountings and fittings:-

15.01 Safety Valve

One gunmetal spring type safety valve complete with cadmium plated spring and padlock. A drain pipe shall be taken from the outlet of each safety valve and terminated 450 mm from floor level clear of all equipment.

15.02 Altitude Gauge

One 100 mm diameter brass cased M.O.W. pattern altitude gauge graduated in metres head and bar with red normal reading pointer, connection screwed 10 mm male B.S.P. The gauge shall be isolated from the cylinder by a 10 mm male gunmetal cock.

15.03 **Thermometer**

One 100 mm diameter vapour pressure rigid stem thermometer calibrated from $O^{o}C$ - $100^{o}c$ complete with separable pocket, shall be installed at the top of the calorifier/cylinder where a true temperature indication may be obtained. The pocket shall be filled with heat conducting grease.

Thermometers shall be as manufactured by The British Rototherm Co. Ltd., G.H. Zeal Ltd., or Negretti and Zambra. They shall be either angle or straight pattern to suit the application.

15.04 **Drain Cocks**

Drain cocks shall be provided as required and shall be 15 mm gunmetal gland type with hose union of the following manufacture.

Hattersley Fig. No. 81 H.U.

16 **Valve Stamping**

The testing and stamping of all valves, stopcocks, fittings, etc. as required by the Local Water Authority shall be the responsibility of the Contractor who shall include in his tender for the payment of all the fees involved.

17 **Regulations**

These installations shall conform to the Bye-Laws for water supply of the Local Water Authority and the Contractor shall include in his tender for meeting all charges which may be made by the Authority relating to the installation.

18 **Keys and Tools**

The Contractor shall supply one key for each item of key operated equipment installed, unless otherwise stated in the particular sections of the specification.

Tools shall be provided only where called for in the particular specification.

All keys and tools shall be handed over by the Contractor to the Employer or his representative on completion of the Contract. He shall obtain a receipt signed by the representative and shall send a copy to the Consulting Engineer as evidence of handing over.

19 **Labels**

All valves except local stopcocks, shall be fitted with identification labels. These shall consist of a circular White/Black/White Traffolite disc with centre fixing hole, secured on the valve spindle by the wheel retaining nut and accommodated neatly within the handwheel. Labels shall be engraved indicating the function of each valve.

20 Testing

All sections of pipework shall be tested in sections during erection and the whole installation on completion. These tests shall be maintained for a period of two hours without loss, in the presence of the Consulting Engineer.

Test pressures shall be as follows:-

Hot and Cold Water Services	4.0 bar gauge
Mains Water Services	7.0 bar gauge

or twice the working pressure whichever is the greater.

21 Commissioning

During the period when the boiler or heat exchanger plant is in operation the hot water service installation shall be fully balanced and regulated and all control equipment shall be calibrated, set and adjusted.

All cold water mains and services shall, before regular use; be disinfected generally in accordance with the procedure detailed in Clause 13.9 of the British Standard 6700 : 1987 'Design, Installation, Testing and Maintenance of Services Supplying Water for Domestic Use Within Buildings and their Curtilages' or as required by the Local Authority.

All draw-off points shall be inspected to ensure that they are operating satisfactorily.

APPENDIX E - THERMAL INSULATION

1 General

This general specification shall be complementary to the following particular specification. All requirements contained herein shall be observed as far as these are applicable, unless such requirements are in conflict with those of the particular specification, in which case the particular specification shall hold.

Thermal insulation shall be applied to all pipework and surfaces from which the emission of heat serves no useful purpose, and is consequently wasteful of fuel, e.g. on distribution lines and hot vessels.

Thermal insulation shall also be applied, as required, on other high temperature surfaces to reduce the surface temperature, e.g. on metal boiler flue connections.

Cold surfaces shall be insulated, as required, as frost protection and as an anti-condensation measure.

Thermal insulation shall be basically either plastic or performed, according to location and application, and shall be reinforced and/or weathered as required.

All insulation shall be free of asbestos.

2 Plastic Insulation

2.01 General

Plastic insulation shall be of the calcium silicate type as Newells 'Superplastic 85', or other equal and approved.

Prior to application, pipes and surfaces shall be wire brushed and given a wash coat of china clay, then plastic composition as described above shall be applied wet in layers not exceeding 15mm thick. Final insulation thickness shall be as called for in Clause 2.11.

Each layer shall be carefully worked on by hand and left with a rough surface to provide a key for later layers. Each layer shall be allowed to dry out completely before the succeeding layer is applied.

2.02 Reinforcement

Plastic insulation applied to surfaces other than pipework, and on pipework of 65 mm nominal bore and above, shall be reinforced by the inclusion of a 20 mm mesh 19 gauge galvanised wire netting embedded between layers. Vertical surfaces, other than pipework, shall be provided with welded studs which shall be embedded in the insulation to prevent vertical slip.

2.03 Hard Setting Finish

After the application of the plastic insulation and reinforcement, a final hard-setting skin incorporating an open-mesh fabric shall be trowelled in and the surface then brought to a smooth finish. Circular surfaces shall be truly circular. The hard-setting compound shall be Keene's cement or equivalent.

2.04 **Edge Finish**

Edges of plastic insulation adjacent to valves, flanges, manholes and similar locations, shall be bevelled down to the metal and trowelled to a smooth finish. In all cases bevelling shall be arranged to permit withdrawal of bolts without disturbance to the insulation.

2.05 **Valves and Flanges**

Where called for in the particular specification, valve bodies shall be insulated and painted in the same manner as pipework.

Valve and pipework flanges shall be insulated if called for in the particular specification, by the 'plumber's joint' method, i.e. after the adjacent valve or pipe insulation has been edge finished and painted, further plastic shall then be applied over the flanges and finished smoothly, leaving a bulbous covering which may be removed without disturbing the valve or pipework insulation.

2.06 **Boiler Flues**

Where called for in the particular specification, internal and external boiler flues shall be insulated by forming a 40 mm air space around the surface, then finishing with plastic insulation.

The air space shall be obtained by spot welding 40 mm long distance pieces to the flue pipes at close centres. These will form the support for a casing of 18 gauge galvanised expanded metal which is to be firmly secured to the distances pieces by double nuts and washers.

On the expanded metal ground, plastic insulation in accordance with Clause 2.01. shall be built up to a thickness of 40 mm applied in three coats. The insulation shall be reinforced by further fixing 15 mm mesh x 18 gauge galvanised wire netting, finished off to a clean surface with a further application of plastic insulation 15 mm thick.

When thoroughly dry and all cracks (if any) are filled in, the insulation shall be finally covered with canvas securely fixed with a suitable adhesive. External flues shall then be waterproofed. Internal flues shall be primed and painted.

2.07 **Waterproofing**

Insulated pipework, valves, flanges, vessels and flues in the open and in ducts and damp indoor locations shall have the insulation weathered by the application of 'Oppanol' thermoplastic sheeting applied in the manner recommended by the manufacturer.
At bends, tees and other difficult points the 'Oppanol' sheeting shall be tailored to shape so as to provide at least a 25 mm overlap. Alternatively for such points 'Oppanol' tape may be used.

2.08 **Painting**

All insulated boiler flue surfaces, other than those waterproofed as described in Clause 2.07. shall be painted with one coat of primer, one undercoat and one top coat of gloss heat-resisting paint in accordance with the colour code for the appropriate surface as indicated hereafter in B.S.S. 1710 : 1984 and all subsequent amendments.

2.09 **Identification**

Identification of insulated surfaces in all areas shall be in accordance with the requirements of B.S. 1710 : 1984 and all subsequent amendments, and as indicated on the schedule forming part of this Specification.

In the Boilerhouse and/or Plant Room, a colour identification chart for the relevant services shall be provided and fixed to the wall in a suitable manner.

In all other locations an abbreviated description of the service shall be stencilled on each colour identification band.

Arrows indicating the direction of flow shall be stencilled on all pipes.

2.10 **Other Recommendations**

The recommendations contained in B.S.S. 1588 : 1949 and 1589 : 1950, shall be adhered to as far as these are applicable.

Special requirements, e.g. metal cladding, air spaces, etc., are detailed in the particular specification.

2.11 **Thickness of Insulation**

The following thicknesses relate to the actual insulant only, and exclude the thickness of any hard-setting skin, waterproofing or other covering which may be applied.

(a) **Hot Surfaces**

Pipes 15 mm to 25 mm bore inc.	25 mm thick
Pipes 35 mm to 65 mm bore inc.	40 mm thick
Pipes 80 mm bore and above	40 mm thick
Flat or curved surfaces	40 mm thick

(b) **Cold Surfaces**

Pipes 15 mm to 40 mm bore inc.	40 mm thick
Pipes 50 mm to 100 mm bore inc.	35 mm thick
Pipes 125 mm bore and above	25 mm thick
Flat or curved surfaces	25 mm thick

In the case of cold water pipework in spaces which are normally heated, where insulation is applied as an anti-condensation measure, a standard 15 mm basic thickness of insulation shall be applied to all sizes of pipework and finished with hard setting.

3 **Pre-Formed Insulation**

3.01 **General**

Pre-formed insulation for pipework shall be as called in the particular specification and shall be one or more of the following categories as required:-

(a) Rigid Calcium Silicate Sections.
(b) Rigid Fibreglass Sections.
(c)Flexible Foam Insulation - 'Foamflex'.
(d) Flexible Foam Insulation - 'Armaflex'.

Preformed insulation for hot and cold surfaces, i.e. tanks and vessels as required, shall be glassfibre sewn sheet mattresses of 130 kg per cubic metre density, or fibreglass slabs as called for in the particular specification.

3.02 **Rigid Calcium Silicate Sections**

These shall be calcium silicate, canvas covered rigid sections in 1.0m lengths which shall be secured to the pipe by fine wire at intervals not exceeding 300 mm. The inner bore of the sections shall be such that close contact with the surface to which it is applied shall be maintained. Joints shall be close butted, segmented round bends and shaped at branches.

The rigid sections shall finally be given a cost of hard setting as described in Clause 2.03.

Insulation thickness shall be as called for in Clause 3.06.

3.03 **Rigid Fibreglass Sections**

These shall be rigid sections in 1.0m lengths which shall be secured to the pipe by metal bands, with Class 'O' foil finish.

The inner bore of the sections shall be such that close contact with the surface to which it is applied shall be maintained. Joints shall be close butted, segmented round bends and shaped at branches.

The canvas covering shall overlap the sections and shall be sealed longitudinally and around the circumference of joints by a suitable adhesive. Final securing bands shall be 25 mm wide non-corrodible metal type and shall be fixed three per section and on bends and branches.

Where special finishes are called for in the particular specification, the metal bands shall be omitted. Insulation thickness shall be as called for in Clause 3.06.

3.04 **Flexible Foam Insulation - 'Foamflex'**

This shall be lightweight, flame resistant, flexible foam insulation in 3.0m long lengths, split longitudinally down one side, as manufactured under the trade name 'Foamflex' by Dunlop Semtex Ltd., or other equal and approved manufacturer, with Class 'O' finish.

The inner bore of the insulation shall be such that close contact with the surface to which it is applied shall be maintained. Each length shall be butt jointed and, together with the longitudinal joint, shall be sealed by an approved adhesive as supplied by the manufacturers.

The insulation shall be taken around large radius bends without disturbance, but on short radius bends and at branches it shall be neatly segmented and sealed as above.

Insulation thickness shall be as called for in Clause 3.06.

3.05 **Flexible Foam Insulation - 'Armaflex'**

This shall be a light weight, flame resistant, flexible foam insulation in 1.0m to 2.0m lengths, un-split for sleeving on to pipework, as manufactured under the trade name of 'Armaflex' by Armstrong Cork Co. Ltd., or other equal and approved manufacturer, with Class 'O' finish.

The inner bore of the insulation shall be such that close contact with the surface to which it is applied shall be maintained. Each length shall be butt jointed and shall be sealed by an approved adhesive as supplied by the manufacturer. Where site conditions require the insulation to be split, the longitudinal joint shall be similarly sealed.

The insulation shall be taken around large radius bends without disturbance, but on short radius bends and at branches it shall be neatly segmented and sealed as above.

Insulation thickness shall be as called for in Clause 3.06.

3.06 **Thickness of Insulation**

The following table sets out the required thicknesses to which the various types of insulation shall be applied.

These thicknesses relate to the actual insulant only and exclude the thickness of any hard-setting skin, waterproofing or other covering which may be applied.

In the table the various insulants are identified as follows:-

Rigid Calcium Silicate Sections (Clause 3.02) (1)
Rigid Fibreglass Sections (Clause 3.03) (2)
Flexible Foam Insulation - 'Foamflex' (Clause 3.04) (3)
Flexible Foam Insulation - 'Armaflex' (Clause 3.05) (4)

HOT SURFACES	(1)	(2)	(3)	(4)
Pipes 15 mm to 25 mm bore inc.	25 mm	32 mm	20 mm	25 mm
Pipes 35 mm to 40 mm bore inc.	25 mm	35 mm	25 mm	25 mm
Pipes 50 mm to 65 mm bore inc.	40 mm	35 mm	25 mm	25 mm
Pipes 80 mm bore	40 mm	35 mm	25 mm	32 mm
Pipes 100 mm bore and above	50 mm	39 mm	44 mm	32 mm

COLD SURFACES	(1)	(2)	(3)	(4)
Pipes 15 mm to 25 mm bore inc.	40 mm	32 mm (38 mm)	20 mm	25 mm (32 mm)
Pipes 35 mm to 40 mm bore inc.	40 mm	32 mm (38 mm)	25 mm	25 mm (32 mm)
Pipes 50 mm to 80 mm bore inc.	40 mm	25 mm (32 mm)	25 mm	19 mm (25 mm)
Pipes 100 mm bore and above.	25 mm	19 mm (25 mm)	25 mm	13 mm (19 mm)

Note: Figures in brackets are for outdoor situations.

3.07 **Sewn Sheet Matresses**

These shall be of the thicknesses specified below, and shall be 1.0m or 450 mm wide as appropriate. They shall be faced on both sides with scrim cloth stitched on with galvanised wire netting and additional cotton canvas covering on the outer surface. Joints shall be close butted with canvas overlap sealed with suitable adhesive.

Welded studs as described in Clause 2.02 shall be provided where necessary.

For flat or circular hot surfaces, insulation thickness shall be 35 mm and for cold surfaces 20 mm.

3.08 **Fibreglass Slabs**

Where called for in the particular specification, sectional pressed steel cold water storage tanks shall be insulated by cutting 25 mm thick type 900 resin bonded fibreglass slabs to fit the recesses around the 'star' pressings in each section, the slabs being secured to the tank body with an approved type adhesive. The complete tank shall then be insulated with a further 25 mm thick type 900 resin bonded slab, firmly secured to the tank body and also to the first layer with the same adhesive.

Rigid fibreglass sections of the necessary inside diameter to fit over the protruding flanges, shall be fixed with adhesive to the type 900 insulation mentioned above. The whole of the tank shall finally be enclosed in plasticized calico canvas secured to the insulation with adhesive, and then primed and painted.

Flat surfaced cold water, oil and feed and expansion tanks shall, where called for in the particular specification, be insulated in a similar manner, but using only one layer of 25 mm thick resin bonded fibreglass.

3.09 **Waterproofing**

The requirements of Clause 2.07 shall apply to this Section.

3.10 **Painting**

The requirements of Clause 2.08 shall apply to Clauses 3.02 and 3.03 only of this Section.

3.11 **Identification**

The requirements of Clause 2.09, shall apply to Clauses 3.02, 3.03, 3.04 and 3.05 of this Section.

3.12 **Other Requirements**

The recommendations contained in B.S.S. 1334 : 1947, shall be adhered to as far as these are applicable.

Other special requirements, e.g. metal cladding, air spaces, etc., are detailed in the particular specification as required.

4 Tolerances and Workmanship

All insulation shall be of uniform thickness, and shall not vary from the thicknesses specified by more than 10%.

The Consulting Engineer shall, at his discretion, test insulation for thickness and concentricity. He shall also, on request, be provided with samples of plastic composition for analysis.

Any insulation work which shall prove to be at variance with the specified requirements, or to be of inferior workmanship, shall be removed and subsequently replaced by the Contractor at his expense.

The Contractor shall be responsible for the protection of all equipment during the application of insulation, and shall remove all waste, surplus materials and packaging from the site immediately on completion. All uninsulated plant and equipment shall be thoroughly cleaned and left clear of fouling by insulating materials or paint.

The Contractor shall employ only skilled specialist operatives in the execution of insulation work, and in this connection should note that the sub-letting of this section of the contract is permissible.

B.S. 1710 : 1960 COLOUR CODE FOR GENERAL SERVICES
(As altered July 1965)

Pipe Contents	Ground Colour		Colour Band	
	Colour	B.S. Colour No.	Colour	B.S. Colour No.
STEAM	Aluminium or Crimson	540	- -	- -
WATER:				
Central heating below 60 C.	French Blue	166	-	-
Central heating 60 C to 100 C.	French Blue	166	Post Office Red	538
Central heating above 100 C.	Crimson	540	French Blue	166
Domestic Hot Water Supply.	Eau-de-nil	216	-	-
Cold Water down service from Storage Tanks.	Brilliant Green	221	-	-
Mains/drinking water.	Aircraft Blue	108	-	-
Boiler Feed	Strong Blue	107	-	-
Condensate	Sky Blue	101	-	-
Cooling (primary)	Sea Green	217	-	-
Treated.	Aircraft Grey Green	283	-	-
Sea,river, untreated.	Grass Green	218	-	-
Hydraulic power.	Mid-Brunswick Green	226	-	-
GAS:				
Town.	Canary Yellow	309	-	-
Butane.	Dark Grey	632	Red	537
Propane.	Dark Grey	632	Red	537
DRAINAGE	Black	-	-	-
FIRE INSTAL-LATIONS	Signal Red	537	-	-
OILS:				
Furnace Fuel	Dark Brown	412	-	-
Diesel Fuel	Light Brown	410	-	-
Hydraulic Power	Salmon Pink	447	Sea Green	217
Transformer	Salmon Pink	447	Light Orange	557
Lubricating	Salmon Pink	447	-	-

Pipe Contents	Ground Colour		Colour Band	
	Colour	B.S. Colour No.	Colour	B.S. Colour No.
AIR: Compressed up to 13.4 bar. Compressed over 13.4 bar. Vacuum	White White White	- - -	- Post Office Red Black	- 538 -
ELECTRICAL SERVICES	Light Orange	557	-	-

1. Colour Bands — Should be approximately 300 mm long and shall be applied by painting or by the use of approved adhesive backed tape.

2. Markings on Pipes and/or Bands — (a) Contents of pipe as column 1 herebefore.
(b) Working Pressure or Head.
(c) Bore of Pipe.
(d) Arrow depicting direction of flow.

3. Lettering — All Lettering shall be black in colour and shall be applied by painting or by the use of approved adhesive backed tape.

APPENDIX F - VENTILATION INSTALLATION

1 General

This general specification shall be read in conjunction with and shall form part of the following particular specification relative to this section. All the requirements contained herein shall be observed as far as these are applicable unless such requirements are in conflict with those of the particular specification, in which case the particular specification shall hold.

2 Ductwork

2.01 The general construction of all ductwork shall be in accordance with the latest specification as published by the H.V.C.A.

2.02 All ductwork specified for internal use shall be manufactured from galvanised sheet steel to the gauges listed in the Table.

2.03 All ducts and branch ducts shall have suitable and sufficient apertures with sealed cover plates to permit all tests indicated in the particular specification to be carried out.

2.04 Longitudinal seams shall be made with the 'Pittsburgh' lap joint, having projecting edges neatly hammered over.

2.05 Circumferential joints shall be made air-tight with 3 mm thick rubber gaskets.

2.06 Slip joints, where necessary for expansion or to facilitate erection, shall be made air-tight with an approved non-poisonous plastic compound.

2.07 Bends shall have a throat radius at least equal to the duct width in the same plane. Where tight bends are unavoidable, internal guide vanes shall be installed. These shall be of specific profile hollow construction with extended leading and trailing edges. Design details and locations shall be approved by the Engineer before manufacture is commenced.

2.08 Branch ducts shall not be taken off a main duct at an angle greater than 45^{o} in the direction of the air flow.

2.09 Transition pieces in ductwork shall have an enclosed angle not exceeding 20^{o}. Transition pieces connecting to fans, heaters, filters or other items of equipment, shall have an enclosed angle not exceeding 50^{o}.

2.10 Where duct branches connect to inlet or outlet registers, they shall be sealed around the spigot connection. Transition pieces shall be installed to effect the required increase in cross-sectional area, and the enclosed angle shall not exceed 40^{o}.

Register inlets and outlets connected to vertical branch ducts shall be fitted with internal guide vanes as Clause 2.07 above.

The interior of ducts behind registers shall be painted matt black with two coats of suitable paint.

2.11 Bolted-on and sealed access covers shall be fitted at 6.0m intervals and adjacent to fans, heaters and filters. The duct openings shall have an adequate compensating ring.

Where ducts are insulated, the doors shall also be insulated.

2.12 Ducts shall be fabricated in sections approximately 2.4m long, and shall be free from sagging and drumming, accurately lined up, true to size, truly air-tight under operating conditions and free from sharp edges or obstructions liable to cause noise.

2.13 Where metal ducts connect to masonary ducts, flanged spigot pieces shall be provided and shall be complete with rage bolts for building-in.

2.14 An inspection door shall be fitted in each duct where fire dampers are located to give access to the fusible link for inspection or replacement purposes.

3 Ductwork Supports

3.01 Supports for ductwork shall be in accordance with the HVCA Specification. Tape shall be fitted between the duct and the angle iron supports to minimise noise.

3.02 Where ductwork is supported from the underside of structural steelwork, the supports shall be in accordance with Clause 3.01 except that the drop rods shall be secured to the steelwork by Lindaptors or other proprietary girder clips. Structural steelwork shall not be drilled to provide support for ventilation ductwork.

3.03 Ductwork supported on brick or concrete piers shall rest on a 15 mm thickness of hair felt, and shall be secured to each pier by a loose 40 mm x 12 gauge mild steel strap placed over the top of the duct and fixed to the pier. Asbestos tape shall be fitted between the duct and the strap.

3.04 Generally, all mild steel angle iron supports, drop rods and straps shall be wire brushed and then painted with one coat of 'Galvafroid' paint before erection.

4 Flexible Duct Connections

On the suction and delivery openings of every fan, air handling unit, or any item of equipment from which noise may be transmitted into the ductwork, a flexible double textured canvas connection at least 150mm long shall be provided and secured by angles or straps to bolted flanges.

In the case of air exceeding a temperature of 50^{o}C, aluminised fire resistant cloth shall be used instead of canvas.

Flexible connections shall consist of, or be protected by, material which shall have a fire penetration tome of at least 15 minutes when tested in accordance with B.S. 476, Part 1, 1953.

5 Regulating Dampers

5.01 Unless otherwise stated, these shall be of the hand operated blade pattern, having the blades constructed from two sheets of galvanised mild steel fitted around the square spindle. The thickness of the steel shall be such as will avoid distortion of the damper. The blade edges shall be folded and left smooth and the blade sides shall be felted to provide a good fit against the sides of the duct.

5.02 The spindle ends shall be machined to fit into the brass bushes of cast iron bosses of the 'Zest' type, which shall be fixed to the sides of the duct. The spindle shall be extended at one end where a quadrant arm with means for adjustment and clamping shall be fitted. The quadrant shall be suitably labelled 'open' and 'shut'.

5.03 Damper assemblies shall be rigid in construction, free from vibration at any setting and reasonably air-tight when closed. They shall be accurately installed in relation to the quadrants to permit free movement without binding.

6 Fire Dampers

6.01 Where called for in the particular specification, Fire Dampers shall be installed in the ductwork.

6.02 Fire dampers shall consist of a 16 WG galvanised steel damper set in a steel frame. The damper shall be constructed to avoid distortion, and shall fit closely when shut against the steel frame with a minimum overlap of 20 mm. The clearance between the edges of the damper and the sides of the duct shall be at least 10 mm for each metre of length of side of the damper.

6.03 Fire dampers shall have a 2 hour resistance in accordance with B.S. 476, Part 1.

6.04 Each damper shall be kept in an 'open' position by a system of light braided stainless steel wire and brass pulleys and a fusible link. In the event of a fire, the fusible link shall melt when temperature reaches 68^{o}C and the damper shall fall shut.

6.05 Access to each fusible link shall be provided by means of a proprietary access door at all fire dampers.

7 Electrical Earth Continuity

The whole of the ductwork system, including the fans, shall be properly earthed and where flexible connections are used, each continuity shall be maintained by bonding metal to metal across such connections using a 2.5 mm^2 P.V.C. sheathed copper earth continuity conductor coloured 'green' and fitted with a plastic label reading - 'ELECTRICAL EARTH - DO NOT REMOVE'.

8 Noise Attenuation of Ducting

8.01 Where indicated on the relevant drawings, a noise attenuation lining shall be provided and installed on the inside faces of ductwork.

8.02 The lining shall be of 25 mm thick flexible fibreglass material backed with a film of Neoprene as manufactured by Fibreglass Ltd., St. Helens, or other equal and approved manufacturer.

8.03 The lining shall be fixed to the ducting using an approved contact adhesive in accordance with the adhesive manufacturers' instructions.

8.04 The Neoprene film shall be placed next to the air stream.

8.05 All joints shall be carefully sealed by means of a self-adhesive Neoprene film.

8.06 Where a noise attenuating lining is specified, the ductwork dimensions shown will allow for the reduction of C.S. Area due to the provision of such lining.

9 Insulation of Ductwork

9.01 Where called for in the particular specification, the outside surfaces of ductwork shall be insulated.

9.02 The insulation shall be 25 mm thick flexible glass fibre foil-backed mat having a density of approximately 20 kgs per cubic metre, and complying with B.S. 476 Class O, Spread of Flame test.

9.03 The sheets shall be carefully cut to exactly enclose each size of duct to be insulated.

9.04 The insulation shall be fixed to the ducting by metal bands at 600mm centres.

9.05 All joints in sheet insulation shall be taped together and the whole covered with 15mm galvanised chicken wire.

10 Anti-Vibration Mountings

Rubber-in-shear, anti-vibration mountings shall be selected and sized for each complete air handling unit and extract fan. The durometer rating shall be as recommended by the rubber manufacturer for the weight of the respective item of equipment.

Where electric motors are arranged for separate mounting from air handling units or extract fans, these motors shall be provided with suitable anti-vibration mountings.

11 Filters

All filter elements shall be inherently non-flammable, or so treated as to retain their non-inflammable properties throughout their working life.

If a Viscous type of air filter is used, the liquid shall have a flash point not less than 177^{o}C.

12 Testing, Balancing and Commissioning

12.01 All runs of ductwork shall be tested after erection for air-tightness, where necessary in the opinion of the Consulting Engineer, ductwork shall be tested in Sections and at various times.

12.02 On completion of the installation, the Plant shall be commissioned and operated for a period of five consecutive days, the plant being allowed to cool nightly.

12.03 During this commissioning period regulating dampers and the various diffusers and registers shall be adjusted and set to obtain the desired air flow conditions.

12.04 Air flow and pressure tests shall be carried out on main and branch ductwork, and for this purpose, test apertures shall be provided in the ductwork as called for in Clause 2.03.

12.05 Where the nature of the installation requires it, dry and wet bulb tests shall be carried out at locations to be decided by the Engineer.

12.06 All heaters batteries shall be hydraulically tested. This test shall be to a pressure of 6.7 bar gauge, and shall be maintained for a period of 2 hours without loss, and in the presence of the Consulting Engineer.

All defects which become apparent shall be made good and the test re-applied.

12.07 During these tests the Engineer or Caretaker in charge shall be given all necessary instructions on the operation of the plant and the maintenance of same. All instruction books, sheets or cards shall be handed over and a receipt obtained.

On completion of these tests the installation shall be left fully operational and to the satisfaction of the Consulting Engineer.

APPENDIX G - MINERAL INSULATED METAL SHEATHED CABLES AND THEIR INSTALLATION

1 Materials

All mineral insulated, metal sheathed cables installed under this Contract shall comply with the following requirements:-

1.01 They shall conform with all relevant and applicable requirements of British Standard Specification B.S. 6207, Part 1 or Part 2 and shall be the product of one or other of the approved manufacturing firms scheduled at the end of this Appendix.

1.02 Mineral insulated copper sheathed cables shall be used exclusively on this Contract unless otherwise stated in the Contract Documents.

1.03 All cables shall be 1000 Volt heavy duty grade unless otherwise called for in the Contract Documents.

2 Installation

All mineral insulated, metal sheathed cables shall be installed to comply with the following requirements:-

2.01 The requirements of the relevant I.E.E. Wiring Regulations with regard to termination, bending, protection against damage by corrosion, heat, fire or explosion, shall be complied with.

2.02 They shall not be buried in building structures in a manner which will render access to them impossible unless the building structures are disturbed.

2.03 All accessories used in connection with the cables and their installation shall be products of the approved cable manufacturers and shall be suitably sized. Jointing, sealing, etc., shall be carried out in strict accordance with the cable manufacturers recommendations. All cable clips used to clip P.V.C. covered MIMS cabling shall be P.V.C. covered copper clips of colour to match the cable.

2.04 All cable terminations shall be sealed by means of ring type gland seals complete with cold sealing, screw-on pots, suitably coloured neoprene sleeving to comply with the I.E.E. Wiring Regulations, and held in position by the special beads and insulating discs provided by the manufacturers. Each sealing pot shall be housed within the body of the gland, care shall be taken to remove all traces of the magnesium oxide from the cores before the seal is made and that the completed seal is not rotated on the cables. All cables shall, where possible, be sealed immediately after cutting but when this cannot be done the cables shall be effectively sealed off with compound to prevent the ingress of moisture.

2.05 At cable terminations each conductor shall be arranged to provide a spare loop of at least 100 mm in length and such loops shall be neatly accommodated without stress or kinking and shall be clear of all fixing screws and mechanisms. Where conductors enter terminals they shall be sufficiently doubled up to fully occupy the terminal hole or slot.

In fuse and switchgear units designed to accommodate lug type connections suitable lugs shall be employed. Lug type terminals for cores, having a cross sectional area of 6 sq.mm or greater, shall be of the cone grip type, but those for cores having a cross sectional area of less than 6 sq.mm shall be of approved soldering or crimping type.

2.06 Cables which are installed on the surface of building structures shall be installed parallel with building lines and shall be neatly clipped using suitable P.V.C. covered twin fixing saddles spaced not more than 400 mm apart.

2.07 Saddles shall be fixed to building structures other than steelwork by means of rawlplugs and roundhead brass woodscrews and to steelwork by means of brass machine screws inserted in tapped holes in the steelwork or secured by suitable lockwashers and nuts.

2.08 Cables shall, as far as possible, be installed in continuous lengths, connections being made only at accessories, but where this is not possible, junction boxes may be installed in approved locations.

Junction boxes must not be concealed in the fabric of the building but shall be installed in accessible and suitable locations. Each junction box shall comprise a suitable galvanised conduit box fitted with approved fixed connector blocks. Loose connector blocks shall not be installed.

2.09 In all locations where single core M.I.M.S. cables are secured to a common gland plate, a suitable gland plate manufactured from non-ferrous metal shall be fitted. If the foregoing shall prove impracticable, a fine slot shall be cut between the gland holes in the ferrous plate.

2.10 All M.I.M.S. cabling erected on the surfaces of building structures between floor level and a height of 1300 mm above such floor level, shall be protected from physical damage by means of a suitably and securely fixed cable guard. Where such a guard shall take the form of conduit, the M.I.M.S. cable shall be glanded to the conduit and the conduit shall be black enamel finish.

2.11 In locations where cables have to be brought a distance of more than 225 mm from walls, floors or ceiling to items of equipment placed away from these surfaces a length of perforated, galvanised cable tray shall be erected for the cables support.

2.12 Where P.V.C. sheathed cables are definitely specified in the Contract Documents, suitable P.V.C. sleeves shall be used to cover all glands and exposed areas of cable sheaths.

2.13 In all circumstances where M.I.M.S. cables approach the terminal boxes of motors, thermostats or other equipment which are subject to movement by vibration or other cause respective to the securely fixed parts of M.I.M.S. cable runs, suitable shock absorbing loops shall be formed in the cables before they are connected to the terminal boxes.

2.14 Where M.I.M.S. cables are installed in formed ducts or trenches which are not accessible throughout their entire lengths, such cables shall not be clipped to the duct or trench surfaces but shall be neatly drawn in and laid on the floors of such ducts or trenches.

All such cables shall be painted with a suitable anti-corrosive paint before installation, or shall be P.V.C. sheathed as particularly specified.

2.15 All ground buried M.I.M.S. cables shall be installed in:-

2.15.01 Earthenware or P.V.C. cable ducts laid in prepared trenches.

or

2.15.02 Prepared trenches. Unless stated to the contrary in the Contract Documents, all excavation, backfilling and proper reinstatement of cable trenches shall form part of this Contract.

The provision and installation of cable ducts and associated trenching will be carried out under this Contract, unless otherwise stated in the Contract Documents.

2.16 Where M.I.M.S. cables are to be ground buried in cable trenches the following requirements shall be complied with:-

2.16.01 Unless approval to the contrary be given by the Consulting Engineers all cables shall be buried at a depth of 750 mm below finished ground level.

2.16.02 Trench bottoms shall be levelled, cleared of all projections and covered with a 50 mm layer of sand. Cables shall be bedded on the sand layer and covered by a similar sand layer before back filling commences.

2.16.03 After inspection by the Consulting Engineers, trenches shall be backfilled with earth, free from coarse materials, in layers about 200 mm deep, and each layer trampled until backfilling is complete. A suitable marking tape shall be installed throughout the complete length of the ground buried cable installation at a depth of approximately 300 mm below finished ground level.

SCHEDULE OF APPROVED CABLE MANUFACTURERS

BRITISH INSULATED CALLENDARS CABLES LTD.,

PYROTENAX LTD.,

MINERAL INSULATED CABLES LTD., OXFORD STREET, BILSTON, STAFFS.

APPENDIX H - ALTERNATIVE EQUIPMENT

1 General

Manufacturer's names listed in the Specification are to be used as the basis for tendering, alternatives are not to be included in the Tender Price.

Alternatives may be entered in the appropriate schedule on the Tender Documents indicating the cost variation to the Tender Price.

APPENDIX I - AS INSTALLED DRAWINGS, BROCHURES AND INSTRUCTION MANUALS

1 General

This Section of the Specification shall cover the preparation and handing over of 'As Installed' drawings, brochures and instruction manuals for the completed Installation.

2 As Installed Drawings

These 'As Installed' drawings shall take the form of one complete set each of ink tracings on film transparencies, 35 mm microfilm on aperture cards as produced by the Microfilm Bureau Ltd., 125 Ormeau Road, Belfast, and prints taken from the transparencies.

The information required to prepare the drawings shall be recorded accurately as the works proceed and when complete shall include the following information:-

2.01 The precise location of all underground services.

2.02 The complete layout of each of the systems forming the completed installation.

2.03 All circuiting information including diagrammatic layout of all distribution boards.

3 Brochures and Instruction Manuals

These Brochures and Instruction Manuals shall take the form of three complete suitably titled, loose leaf binders each of which shall include the following information:-

3.01 An introduction to, and general description of the installation, its plant and its operation.

3.02 Starting and stopping instructions noting any sequencing of safety arrangements.

3.03 Instructions for routine maintenance with charts showing the quantity and type of lubricant to be used together with the recommended frequency of application. Instructions for the stripping, inspection, re-assembly, testing and re-commissioning of the plant. Where applicable, fault-finding charts to assist in locating faults.

3.04 Spare and replacement parts lists with the names and addresses of suppliers and the procedures to be followed for the purchase of such parts.

3.05 A complete list of the equipment supplied with details of manufacturers, model, types and serial numbers and where applicable copies of manufacturers catalogues for each item.

3.06 Copies of all manufacturers wiring schematics. In the case of control panels full wiring diagrams shall be included.

4 Lump Sum Form of Tender

The cost of the preparation and submission of the 'As Installed' drawings, brochures, etc., shall be included in the appropriate space in the Lump Sum Form of Tender. Tenderers shall note that the drawings etc. are required to be submitted to the Consulting Engineers for approval and/or comment not later than two weeks before the programmed completion date for the works and that one set each of both the transparencies, prints and brochures etc., are to be handed over to the Employer at the Take-Over Inspection. Under no circumstances will a Certificate of Practical Completion be issued until drawings etc., have been submitted.

APPENDIX J - TESTING AND COMMISSIONING OF COMPLETE INSTALLATION

1 The Contractor shall test and commission the complete installation on completion of all the works in accordance with the relevant clauses of this Specification, the attached appendices and as specified hereafter and shall provide all the necessary instruments and personnel to carry out this testing and commissioning. Where the Institute of Building Services has published Codes of Practice for commissioning and testing, these shall be followed.

2 The Mechanical Contractor shall demonstrate to the Engineer's satisfaction that the flow rates, outputs, temperatures, pressure efficiencies, etc. are in accordance with design conditions and also demonstrate that the automatic controls and instruments are operating satisfactorily and shall further demonstrate that his testing instruments are accurate following the completion of the entire installation. Tests to be repeated due to defective workmanship shall be at the Contractor's expense.

3 Specialist items of plant and equipment shall be tested and commissioned by the Specialist Supplier or his Representative, and shall be demonstrated by same also.

4 Each installation shall be fully commissioned including balancing, regulation and adjacent of controls. Particular attention should be paid to the maintenance of cleanliness of all plant and distribution systems during construction, to the protection of plant from other trades, and the protection of electrical equipment from damp.

5 Balancing and adjustment of valves shall be carried out in the presence of the Engineer or his Representative.

6 No balancing or commissioning shall be carried out until the installation is completed, and until flushing, cleaning and hydraulic testing has been completed.

7 The boiler system shall be brought slowly to the design operating temperature and pressure and regulation carried out to ensure that the system is working in accordance with the design conditions.

8 The Contractor shall provide all necessary personnel to operate the plant for a period of 7 twelve hour days, during which period the Employer operating staff shall be given full instructions in the correct operation and maintenance of the plant.

9 Efficiency tests shall be carried out on each of the pumps in the presence of the Engineer to ascertain that the performance, pump outputs, kW inputs, etc., are satisfactory and that the works test figures are possible under site conditions.

10 The Contractor shall include for revisiting the works during the defects liability period to check, balance and adjust the plant as necessary.

11 This Contract shall include for the supply and delivery of an initial supply of fuel oil for all necessary commissioning and balancing unless indicated otherwise in the particular Specification.

12 The Contractor shall submit to the Engineer the following information:-

- 12.01 The setting of all valves.
- 12.02 The setting of all dampers.
- 12.03 The flow and return temperatures at all equipment.
- 12.04 The running amps of each pump and burner.
- 12.05 The outside temperature at the time of the test.
- 12.06 The inside temperature at the time of the test.
- 12.07 System operating pressures.
- 12.08 Equipment noise levels.

13 Efficiency tests shall be carried out on each boiler in the presence of the Engineer to demonstrate that each boiler will obtain the efficiency declared, and the tests shall include the following:-

13.01 Period of test.
13.02 Fuel consumption and C.V. of fuel.
13.03 Boiler flue and return temperature.
13.04 Flue gas temperature.
13.05 Flue gas percentage CO_2
13.06 Boiler draught.
13.07 Boiler room temperature.
13.08 Heat meter readings.
13.09 Boiler efficiency.
13.10 Percentage excess air.

14 Fan volumes and major air flow quantities shall be measured using a pitot tube and inclined manometer, with the multi-point traversing technique.

15 Specific items to be recorded are as follows:-

15.01 External temperatures - dry bulb and R.H. (relative humidity).
15.02 Air dry bulb temperature and R.H. in each space.
15.03 Air dry bulb temperature and R.H. in each main return duct.
15.04 Air dry bulb and R.H. before and after each heater.
15.05 Air dry bulb and R.H. after mixing chambers.
15.06 Air dry bulb and R.H. in each main supply duct.
15.07 Fresh air quantity m^3/sec.
15.08 Air volume (m^3/s) and pressure drop (N/m^2) across each fan.

15.09 Air volume (m^3/s) and pressure drop (N/m^2) across each filter.
15.10 Air volume (m^3/s) and pressure drop (N/m^2) across each heater.
15.11 Air volume (m^3/s) in each main supply and return duct.
15.12 Air volume (m^3/s) at each grille and diffuser.
15.13 Fan and motor speeds.
15.14 Running currents for each motor.

16 The Contractor shall provide three sets of Operating and Maintenance Instructions including:-

16.01 Brief outline of the plant.
16.02 Starting and stopping instructions noting any sequencing of safety arrangements.
16.03 Details of required maintenance with suggested frequency of action.
16.04 Details of all oils, grease and filters required together with a suggested list of spares.
16.05 Details of each item of equipment giving name and address of manufacturer, local agent, type, model and all details of equipment.
16.06 One set of 'As Installed' Drawings.

17 The Operating and Maintenance Instructions shall be handed over not later than the end of the commissioning period.

18 The Main Contractor is responsible for the gradual raising of the temperature to the Architect's requirements. However, the Contractor shall allow in his tender for seven, twelve hour days assistance to the Main Contractor, when under the Main Contractor's direction, temperatures will be taken on a half hourly basis and valves manually modulated to ensure a temperature rise not greater than that asked for by the Main Contractor.

19 This work to be under the supervision of the Main Contractor's staff or alternatively the Clerk of Works for the duration of operation.

During all testing, struct frost protection measures must be observed or alternatively tests discontinued and pipework drained down before leaving overnight. The Mechanical Contractor shall be held responsible for such damage to pipework and subsequent damage to surroundings.

APPENDIX K - EXISTING SERVICES

1 General

The Tenderer shall note that drawings showing existing services, where these have been included in the tender documentation, may not be a true record.

The drawings shall be regarded as giving a general indication only of existing services, and shall not be regarded as giving an accurate representation of the existing services installation.