

2.1 GENERAL

This part of the specification clearly defines the class and quality of materials to be installed and standards of workmanship to be undertaken and shall be strictly observed in the absence of specific details defined in this or other parts of this Specification or shown on the drawings.

2.2 BOILER PLANT

COMMERCIAL & INDUSTRIAL BOILER PLANT

General

Boilers and their firing equipment shall be of a standard design and shall conform to the relevant British Standards or EN Standards, and the duties indicated on the schedules and as further specified in **Part 3** of this specification.

Each boiler shall be supplied complete with all safety controls, the necessary fittings and equipment for automatic control, a set of flue and tube cleaning tools, and be mounted on a base constructed in accordance with the Manufacturer's details and requirements. The Manufacturer shall provide firing equipment that matches the boiler to provide the stated duties. The space allocated to allow for the correct functioning and for maintenance to be carried out shall be confirmed with the Manufacturer. Sizing, arrangement and compatibility of the flues shall be confirmed with the Boiler Manufacturer. Any discrepancies shall be advised to the Engineer.

Materials & British Standards

As indicated in **Part 3** of this specification and schedules, the boilers shall be manufactured from:-

- Cast iron, copper, steel or stainless steel for LTHW (up to 95°C) and HWS generators.
- Cast iron, steel or stainless steel for MTHW (95°C up to 120°C)
- From steel **only** for HTHW (pressurised above 120°C up to 150°C) and steam installations.
- LTHW and MTHW steel boilers shall also be built to BS 855 or BS 2790 as applicable.
- LTHW and MTHW cast iron boilers shall be to BS 779.

Cast iron and boilers shall only be used up to 3.1 Bar pressure.

NOTE:

The use of BS 855 is restricted to steam boilers of rated output 45kW to 150kW with maximum operating pressure of 2 Bar and to hot water boilers of rated output 45kW to 3MW with maximum operating pressure of 4.5 Bar and maximum operating temperature of 125°C. In cases where the above limits are exceeded, BS 2790 will be applicable.

Firing Equipment

The boilers shall have oil fuel automatic burners; gas burners with automatic forced draught or atmospheric burners; or automatic dual fired oil/gas burners (as defined in **Part 3**) and arranged to shut down in the event of failure to ignite or loss of pilot light.

The efficiency of the matched boiler/burner combination unit shall be based on the gross calorific value of the fuel, and shall be a minimum value over the full firing range as follows:-

82% for oil.

81% for gas up to 1.3 MW rating.

82% for gas above 1.3 MW rating.

The efficiency testing for factory assembled "packaged" units shall be carried out on site in accordance with BS 845:Part 2 and test certificates supplied where specified in **Part 3** of this specification.

On/off burners to be used up to 50kW unless otherwise specified in **Part 3** or if a particular make of boiler has a requirement for two stage low fire start.

2.2 BOILER PLANT

Metering equipment for gas and oil firing shall be provided in the fuel supply to the burner if specified in Part 3.

Combustion conditions test points shall comprise suitable connections for the insertion of portable instrument probes for measurement at the boiler exit in the case of all fuels to measure flue gas temperature, flue gas oxygen, carbon dioxide and carbon monoxide content and for oil additionally include for connections for smoke measurement.

Remote Control

Each boiler shall be provided with volt free contacts (which will be enabled from elsewhere and form part of the stop/start circuit, with exception of steam boilers), a set of volt free contacts that shall make when the boiler is firing and a volt free contact that shall make on any of the boiler alarms - as indicated in the schedules.

Insulation, All Boilers

Water backed surfaces shall be externally insulated with not less than 75mm thickness of mineral wool to BS 3958:Part 5 with "K" value of 0.05W/M² at 100°C mean temperature, and clad with removable metal sheets or panels.

Surface temperatures of cladding not to be greater than 50°C on parts which must be touched, nor greater than 80°C on parts which could be touched accidentally.

Hot flue gas surfaces to be insulated to reduce heat loss and contact temperature.

Nameplate, All Boilers

All boilers shall have a nameplate fixed to the boiler, indicating:-

- Manufacturer's name and identification mark.
- Inspecting Authority's mark.
- Hydraulic test pressure.
- Date of hydraulic test.
- Design pressure.
- BS Number/EN Number.
- Rated continuous output, number of sections (if cast iron) and fuel.
- Serial No. of boiler.

Tests, All Boilers

The tests shall demonstrate that the performance criteria have been met, and shall include the following which are to be conducted on site at the conclusion of commissioning. All tests to be witnessed and the results recorded:-

- Efficiency Test.
- Combustion Test.
- Boiler Rating Test.
- Turn Down Test.
- Noise Criteria Test.
- Composition of Exhaust Gas Test.

Tests shall be made to ensure that the controls operate as intended and if systems or components malfunction they shall return to a fail-safe condition.

2.2 BOILER PLANT

Water Treatment, All Boilers

Pre-treatment plant shall be provided all as indicated in the schedules or in **Part 3** of this specification.

Site Installation & Testing of Boiler & Firing Equipment

The boilers shall be erected on prepared foundations and commissioned by the Boiler Manufacturer and thoroughly cleaned out of all debris, grease etc. before filling with water as BS 2486 and then subjected to a site hydraulic test (and on steam boilers a boil out if specified in schedule). Protection against internal corrosion should be provided if the boiler is not to be used for some time, as specified in BS 2486.

NOTE:

Steam systems to be filled from a full boiler feed tank by the Boiler Commissioning Engineer.

HOT WATER BOILERS

Mountings & Fittings

(a) Mountings & Fittings for LTHW & MTHW Boilers up to 3MW Output and/or 4.5 Bar

Each boiler shall have screwed and/or flanged connections to BS 21 and BS 4504 and be delivered with all connections blanked or capped off. These connections shall include flow and return tappings, open vent, safety valve, drain cock and instruments listed below:-

- **Emptying/Drain Cock** - Bronze gland pattern with hose union and malleable iron handle to BS 2874.
- **Thermometer** - Bezzel type calibrated 0°C to 120°C or mercury in steel type, calibrated 0°C to 120°C with divisions at 1°C intervals and numbered at 10°C intervals with bold figures.
- **Altitude or Pressure Gauge** - Calibrated in both bar and metre head, to approximately twice the working pressure of the system over 3 MW and adjustable red dial pointer set at normal working pressure or head of the system generally to comply with BS 1780:Part 2. Complete with lever handle, cock and siphon.
- **Flame Observation Port**
- **Safety Valve** - To BS 6759, enclosed spring loaded pattern fitted with padlock and galvanised steel (medium grade) discharge pipe run clear of any insulation to terminate 150mm from floor level at the side of the boiler.
- Each boiler shall have access provided where operations may be carried out more than 2m above firing floor level and include for gauges to be clearly visible from firing floor.
- Level controls and alarms shall meet the requirements of HSE Guidance Note PM5.

(b) Mountings & Fittings for Hot Water Boilers that exceed 3 MW Output and/or 4.5 Bar

- Each boiler shall have flanged connections to BS 4504 and be delivered with all connections blanked or capped off.
- Connections on the boilers should include; flanged flow and return tappings, safety valve, drain cock and instruments listed above or in schedules.
- **Emptying/Drain Cock** - Bronze gland pattern with hose union and malleable iron handle to BS 2874.

2.2 BOILER PLANT

- **Thermometer** - Bezzel type calibrated 0°C to 120°C or mercury in steel type, calibrated 0°C to 120°C with divisions at 1°C intervals and numbered at 10°C intervals with bold figures.
- **Altitude or Pressure Gauge** - Calibrated in both bar and metre head, to approximately twice the working pressure of the system over 3 MW and adjustable red dial pointer set at normal working pressure or head of the system generally to comply with BS 1780:Part 2. Complete with lever handle, cock and siphon.
- **Flame Observation Port** - Located in door and also near observation port.
- **Safety Valve** - Double high lift type, steel body, nickel alloy lid and seat, stainless steel spindle, locking cap, padlock, duplicate keys, easing lever, galvanised steel drain led clear of lagging to firing floor. To be flanged to BS 4504.
- Each boiler shall have access provided where operations may be carried out more than 2m above firing floor level and include for gauges to be clearly visible from firing floor.
- Level controls and alarms shall meet the requirements of HSE Guidance Note PM5.

Hot Water Boiler Safety Controls

Safety control components shall be fitted to boilers, burners and/or pressurisation equipment and shall be connected together into a single homogenous control system.

Lock-out control devices shall be protected against unauthorised interference, and they shall require to be reset by hand. Unless otherwise indicated, controls, other than lock-out controls, shall recycle and restart if and when the relevant operational condition is restored to normal.

Hot Water Boiler Indicator Lights & Alarms

Hot water boiler plant shall be provided with the following state or fault lights as follows:-

Equipment (eg. Burners, pumps etc.) on.	High temperature lock-out.
Equipment running.	High pressure.
Equipment lock-out.	Low pressure.
Flame or pilot flame failure.	Low pressure lock-out.
Ignition failure.	Low water level alarm.
Fan failure.	Low water level lock-out.
Flue damper failure.	Low level in spill tank.
Control equipment failure.	Other as indicated in schedules.

The fault conditions as described above shall give rise to unmistakable audible and visual alarms at the boiler plantroom/s, which are clearly distinguishable against the ambient noise conditions. The types and precise locations of sounders and beacons shall be as scheduled and shown on the drawings.

Hot Water Multi-Boiler Installation Controls

Multi-boiler installations shall be arranged for sequence control unless otherwise specified in **Part 3**.

STEAM BOILER PLANT

Steam boilers shall be either steel, 3-pass economic boilers (or steel 3-pass reverse flame boilers up to 3.5MW) as defined in **Part 3** of this specification and the schedules.

2.2 BOILER PLANT

In addition, to be to the requirements of BS 855 or BS 2790 and as specified in **Part 3**. The following shall apply to all steam boilers:-

- An observation port complete with sight glass of minimum diameter 50mm shall be provided for each furnace tube. The port shall be positioned at the rear of the gas reversal chamber to view the flame within the furnace tube. The sight glass shall be readily removable to enable the use of water cooled suction pyrometers.
- The attachment of tubes to the first-pass reversal chamber tube plate in shell boilers built to either BS 2790 or BS 855 shall be as follows:-
 - Boiler built to BS 2790:
 - Stay tubes - Figure 3.9.2.(1)(d)
 - Plain tubes - Figure 3.9.2.(1)(d) or Figure 3.9.2.(2)(b)
 - Boilers built to BS 855:
 - Stay tubes - Figure 26(d)
 - Plain tubes - Figure 26(b) or Figure 26(d)
- The heat release rate to each furnace tube, based on the fuel input (gross calorific value) OR the nominal output at an assumed 80% efficiency, shall not exceed 1800 k W/m³.
- The hot face metal temperature of the first-pass reversal chamber tube plate calculated in accordance with BS 2790 Appendix C shall not exceed 380°C.
- The gas-side resistance between the firing equipment and the boiler exit shall not exceed 15 mbar/(1500 Pa).
- The boiler shall be capable of satisfactory operation using water having total dissolved solids up to 3550 ppm.
- The water surface area in the steam shall be sufficient to ensure that the steam disengagement velocity does not exceed 0.06 m/s at working pressure.
- The steam at entry to the pressure main shall have a minimum dryness fraction of 0.98.
- Boiler exit gas temperatures shall not exceed 260°C. Unless otherwise indicated, boiler exit gas temperatures on oil fired installations shall not fall below 180°C.

Steam Boiler Equipment & Mountings

Equipment for steam boilers shall comply with BS 759 and shall include the following for each boiler and positioned in accordance with Manufacturer's standard arrangements:-

- Two safety valves, mounted either singly or as a part on a common body.
- Lockable stop valve positioned as close as possible to the boiler.
- Steam pressure gauge.
- Two independent water level gauges of the sequencing blow-down type directly connected to the boiler shell (except boilers of less than 145 kg/hour capacity for which one water level gauge is acceptable).

2.2 BOILER PLANT

- External feed water control, high and low water level control and alarms, and an independent overriding low water level control with its alarm, each fitted with sequencing blow-down valves and lockable steam isolating valves OR direct mounted internal level control with alarm OR directed mounted internal level controls of the self-checking type with alarms as defined in HSE Guidance Note PM5 and to the requirements of **Part 3** of this specification and the schedules.
- Inspector's test cock.
- Lockable feed stop and check valve.
- Tapping for chemical injection point as indicated in the schedules or in **Part 3**.
- Manual blow-down valve (handle only removable when valve is closed) with a single handle for a range of boilers plus automatic blow-down valve plus automatic blow-down valve with TDS (Totally Dissolved Solids) control with heat recovery, as indicated in the schedules and **Part 3**.
- Connections for pressure controls of fixing appliance.
- Means for attaching a test pressure gauge.
- Boiler water sampling valve and cooler.

Access

Each boiler shall have access provided where operations may be carried out more than 2m above firing floor level and include for gauges to be clearly visible from firing floor.

Steam Boiler Blow-Down

Blow down systems shall comply with BS 806 and BS 759 and shall be as described in **Part 3** of this specification.

Chemical Conditioning Equipment for Steam Systems

The installation shall have a chemical solution injection system served from the water pre-treatment plant complete with mixing tank with integral agitator, injector pumps and a dosing pot.

Steam Boiler Safety Controls

Safety control components shall be fitted to boilers, burners and the components shall be connected together into a single homogenous control system, and shall comply with the relevant British Standard and to the recommendations from "National Vulcan Safety". Control panels shall comply with the requirements of the Association of Technical Committees (AOTC).

Each steam boiler shall have an automatic firing control system that effectively controls the supply of fuel and air, and shuts them off in the event of faults.

2.2 BOILER PLANT

Steam Boiler Indicator Lights & Alarms

Steam boiler plant shall be provided with the following state or fault lights as indicated:-

Equipment (eg. Burners, pumps etc.) on.	First low water level alarm.
Equipment running.	Second low water level lock-out.
Equipment lock-out.	High water level.
Flame or pilot flame failure.	High pressure lock-out.
Ignition failure.	Others as indicated.
Fan failure.	
Flue damper failure.	
Control equipment failure.	

The fault conditions as described above shall give rise to unmistakable audible and visual alarms at the boiler plantroom/s, which are clearly distinguishable against the ambient noise conditions.

Boiler Feed Pumps (Steam Boilers)

Feed pumps shall be electrically driven, multi-stage centrifugal type mounted on the boiler base frame and automatically controlled via water level controller which is EITHER ON/OFF OR by means of a modulating feed water valve and recirculating device (as indicated in the schedules).

They shall be rated at MCR (Maximum Combustion Rating) of boiler plus 20% and complete with mechanical shaft seals, interconnecting wiring to level controller, suction strainer and isolating valve and non-return discharge valve.

DOMESTIC BOILER PLANT

General

Boilers and their firing equipment shall be of a standard design and shall conform to the relevant British Standards or EN Standard, and the duties indicated on the schedules and as further specified in **Part 3** of this specification.

Each boiler shall be supplied complete with all safety controls, the necessary fittings and equipment for automatic control, a set of flue and tube cleaning tools, and be mounted on a base constructed in accordance with the Manufacturer's details and requirements. The Manufacturer shall provide firing equipment that matches the boiler to provide the stated duties. The space allocated to allow for the correct functioning and for maintenance to be carried out shall be confirmed with the Manufacturer. Sizing, arrangement and compatibility of the flues shall be confirmed with the Boiler Manufacturer. Any discrepancies shall be advised to the Engineer.

Open Flue Gas Fired

Floor standing/wall hung open flue gas boiler suitable for use in open vented circulation systems or sealed systems, as defined, and combined pumped heating and pumped or gravity indirect hot water supply shall be provided all as specified below and indicated in schedules and in **Part 3** of this specification.

The heat exchanger shall be of cast iron monobloc casting or sectional construction with combustion chamber and flue hood manufactured in coated sheet steels to resist corrosion. An integral draught diverter shall be incorporated. (Alternatively, when specified in **Part 3** or defined in the schedules, the boiler may be constructed with a copper heat exchanger.)

The boiler shall be fitted with stove enamel casing, multi-function gas control and flame failure device, thermostat and automatic ignition. Electronic programmer shall be incorporated within the boiler casing or remote wall mounted as indicated on the drawings or defined in **Part 3**.

2.2 BOILER PLANT

The boiler shall comply with BS 5258:Part 1 and BS 6332:Part 1 and be acceptable to the Gas Supplier.

Installation, operating and maintenance instructions shall be provided with each boiler assembly.

Balanced Flue Gas Fired

Floor standing/wall hung balanced flue gas boiler either natural draft or fan assisted as defined.

Suitable for use in open vented or sealed systems, as defined, and of combined pumped heating and pumped or gravity indirect hot water supply shall be provided all as specified below and indicated on the schedules and in **Part 3** of this specification.

The heat exchanger shall be of copper or cast iron monobloc casting or sectional construction with combustion chamber, flue hood and balanced flue assembly manufactured from coated sheet steel.

The boiler shall be fitted with stove enamel casing, multi-functional gas control and flame failure device, thermostat and automatic ignition. Electronic programmer shall be incorporated within the boiler casing or remote wall mounted, as indicated on the drawings or in **Part 3**.

The boiler shall comply with BS 5258:Part 1 and BS 6332:Part 1 and be acceptable to the Gas Supplier.

Installation, operating and maintenance instructions shall be provided with each boiler assembly.

In instances where a flue terminal is positioned within 2m of the ground or other surface to which the public has access, it shall be fitted with a wire cage protective guard.

The flue terminal clearances/siting shall be in accordance with BS 5440:Part 1.

*** Balanced Flue Gas Fired Combi**

Wall hung multi-directional fanned balanced flue combi gas boiler for use with fully pumped sealed heating installation and domestic hot water supply at direct mains pressure shall be provided as specified below and detailed in the schedules and **Part 3**.

The heat exchanger shall be of copper construction designed to provide separate and independent passage for central heating hot water and domestic hot water. The combustion chamber, flue hood and balanced flue assembly shall be of coated sheet steel to resist stains and corrosion.

The boiler shall be fitted with stoved enamel casing enclosing circulation pump, multi-functional gas control and modulating burner, expansion vessel, diverter and safety valves, pressure gauge, thermostat, automatic ignition and integral programmer or remote wall mounted as specified in **Part 3**.

The boiler shall comply with the relevant requirements of BS 5258:Part 1 and BS 6332:Part 1 and be acceptable to the Gas Supplier.

Installation, operating and maintenance instructions shall be provided with each boiler assembly.

In instances where a flue terminal is positioned within 2m of the ground or other surface to which the public has access, it shall be fitted with wire cage protective guard.

The flue terminal clearances/siting shall be in accordance with BS 5440:Part 1.

In hard water areas, as indicated in the schedules or **Part 3**, an in-line scale inhibitor of a type listed in the WRC Fittings and Materials Directory shall be installed in the cold water supply.

2.2 BOILER PLANT

Oil Fired Domestic Boilers

These shall be generally as defined for gas fired boilers but shall generally be of steel construction unless otherwise specified, and the heat exchangers shall be of a material to suit the fuel.

They shall conform to the British Standard in relation to thermal performance and to British Standard.

FLUE SYSTEMS

The flue system shall be as defined in **Part 3** of this specification and as shown on the drawings.

Chimneys shall be designed, manufactured and erected in accordance with BS 4076, BS 5854 or other standard specified. They shall have design life corrosion allowances as indicated in **Part 3** or on the schedules. Proprietary chimney systems conforming to BS 4543 may be accepted as indicated in **Part 3**.

Chimneys shall be provided with liners constructed of steel or proprietary products as indicated in **Part 3**.

Flues shall be constructed of carbon steel or proprietary products incorporating easy bends insulated as necessary to minimise condensation of flue gases. Jointing materials shall be heat-resisting.

Gas fired boilers shall be provided with carbon steel, single wall stainless steel or aluminium twin walled proprietary flues as specified in **Part 3**.

Boiler flue ducts shall have insulated supports and shall be provided with cleaning doors.

Where a flue duct enters a brick or concrete chimney or passes through a wall, the Contractor shall provide a metal sleeve for "building in". The space between the sleeve and the flue duct shall be packed with heat resistant material.

Flue ducts shall have an upward rake and shall finish flush with the inside face of the chimney flue. Where a flue duct is required to be connected either to a self-supporting steel chimney, or to a proprietary type of flexible chimney lining, the manner of connection shall be as specified in **Part 3**.

Diluted flue systems for gas fired boilers shall be in accordance with the recommendations in British Gas Corporation Publication "Flues for Commercial and Industrial Gas Fired Boilers and Air Heaters" - IM11.

2.3 HEAT EMITTERS

RADIATORS

General

Radiators shall be of the type, rating and dimensions indicated on the drawings, in **Part 3** of this specification and in the schedules; and manufactured and tested in accordance with BS 3528.

They shall be tested at works hydraulically to a pressure of 7 bar/700kPa or twice the working pressure, whichever is the greater.

Radiators shall be delivered to site with plugged ends, clean and free from rust and painted one coat primer at works for final finish on site by others (except aluminium) or factory applied self-finish with protective covering as defined in **Part 3**.

Radiators shall be supported on Manufacturer's standard brackets fixed to the supporting builderswork with screws and plugs or built in to suit the wall construction.

Each radiator shall be fitted with a concealed air vent plug, an isolating valve on the flow connection and a key operated lock shield valve on the return connection. Valves shall be fitted with a union connection.

A thermostatic valve shall be provided on the flow connection where specified on the drawings and schedules or in **Part 3** of this specification.

The radiators shall be installed with a minimum of 150mm clearance between the underside of the radiator and the finished floor level or trunking system unless otherwise specified. Where pipework is routed below the radiators there shall be a minimum of 100mm from the lowest pipe to the floor level.

An allowance shall be made for the radiators to be taken down, connections plugged and radiators refixed once after initial installation for the convenience of other trades.

If the connections are both at the bottom of the radiator, then a device should be included in the design of the radiator to eliminate short circuiting of the water.

Cast Iron Radiators

Cast iron radiators shall be grey cast iron, not less than Grade 12 of BS 1452, have a minimum thickness of 2.5mm, and be free from scale and sand. Column type being made up with individual nipples.

Mild Steel Radiators

Mild steel radiators shall be fabricated from scale free mild steel sheet, not inferior to classification CR1-4 of BS 1449:Part 1 and have a minimum thickness of 1.110mm. Panel type being welded at the seams, between waterways and where fins are fitted. Column type similar to cast iron radiators.

Aluminium Radiators

Aluminium radiators shall be pressure die-cast or extruded construction, generally made up as cast iron radiators. Finish to be stove enamelled or anodised as specified.

Radiator Top Shields

Radiator top shields where specified shall be fitted centrally, 110mm above the radiator top and secured and sealed to the wall surface. The radiator duty shall be such that the reduction in output caused by the top shields is taken into account.

2.3 HEAT EMITTERS

Low Surface Temperature Radiators (Cased)

The low surface temperature radiators shall be of the type, rating and dimensions as specified in **Part 3** of this specification and as indicated on the schedules and drawings.

The maximum surface temperature shall not exceed 43°C as defined in the Health Guidance Note “Safe Hot Water and Surface Temperature 1992”.

The complete unit shall comprise of a heat emitter enclosed in a sheet steel casing which shall have a rated output, with the top grille in place, in accordance with BS 3528 tests.

The heat emitter section shall be fabricated from scale-free mild steel plate to classification CR1-4 of BS 1449:Part 1 and have a minimum thickness of 1.2mm.

The unit shall be tested hydraulically at works to a pressure of 7 bar/700kPa or twice the working pressure whichever is the greater.

The heat emitter section shall be either tubular steel construction with welded louvres to achieve maximum surface area for heat transfer or of steel panel construction with welded louvres to achieve maximum transfer or of steel panel construction as defined in the schedules or **Part 3**.

The casing for the unit shall be fabricated from sheet steel to a minimum thickness of 1.2mm, except on health care projects where the thickness shall be 1.6mm, unless further defined on the schedules or in **Part 3**.

Casings shall be free from sharp corners and shall extend to floor level, unless otherwise specified, in order that pipework is totally contained within the casing,

An air inlet grille shall be incorporated within the front of the casing at low level to allow natural convection. These shall be a removable, continuous grille of liner construction to allow maximum air flow and it shall be a bolt-down or clip-down type to ensure secure fixing as defined in the schedules and in **Part 3**.

The front panel of the casing shall be easily removable for cleaning and maintenance.

The heat emitter and its casing shall be completely de-rusted and either finished with two coats of primer paint before leaving the Manufacturer’s works for final finish on site by others, or have factory applied self-finish and protection against damage, as defined in the schedules or in **Part 3**.

Air vents shall be provided in a position that will ensure complete evacuation of air and be easily accessible from the top or front.

Where pipework connections are defined as bottom flow and return, a device shall be fitted in the heat emitter at works to prevent short circuiting.

Isolating and balancing valves shall be provided in each section of the units unless otherwise specified.

Thermostatic valves shall be provided where specified and where called for shall protrude through the casing side or front panel for adjustment purposes.

Wall mounting brackets shall be provided unless feet for free-standing application are specified. Any free-standing units shall be provided with a back plate which can be plain sheet steel or to a finish defined for the units casing in general.

2.3 HEAT EMITTERS

NATURAL CONVECTORS

Natural Convectector Units

Convectors shall be of the type, rating and dimensions as specified in **Part 3** of this specification and indicated in the schedules.

They shall be manufactured and tested in accordance with BS 3528 and shall be floor, wall or recessed mounting pattern with louvred grilles and damper control as indicated in the schedules or in **Part 3**.

The casing to be fabricated from mild steel sheet, of 1.2mm minimum thickness, with easily removable front panel to facilitate cleaning and access to valves etc. Suitable stiffening is to be applied and casing to be completely de-rusted and finished with two coats of primer paint before leaving Manufacturer's works for final finish on site by others, or a factory applied finish suitably protected, as indicated in **Part 3**.

Heating elements shall comprising solid drawn copper tubes expanded into close metallic contact with aluminium plate type fins or 1mm minimum thickness brazed into headers having BSPT female connections.

The element to be hydraulically tested at Manufacturer's works to a pressure of 20 bar/2000kPa or twice the working pressure specified, whichever is the greater.

Heating elements shall be fitted with air vents, positioned to ensure complete evacuation of air, and accessible from the front.

Each convector shall have its individual isolating and regulating valves and, where called for, space within the casing shall be allowed for these.

Control dampers where specified shall be capable of controlling emission down to 30% of rated output. Damper control shall be easily operated and unobtrusive.

Convector grilles shall be located on top or front of the casings as indicated on the schedules or in **Part 3**. Unless otherwise indicated, grilles shall be Manufacturer's standard and must be of a neat and simple appearance.

Floor mounted convectors shall be supported on purpose made pressed steel feet located to conceal the pipework connections and raise the convector a minimum of 100mm above the finished floor level.

Wall mounted convector casings shall be locally strengthened to support the unit weight, the units shall be securely fixed to the wall or partition.

The convector shall be suitably sealed behind the unit in open contact with the wall surface and protected from damage after installation. The casing interior shall be thoroughly cleaned and element fins combed before commissioning.

Natural Continuous Perimeter Convectors

The convectors to be to the type, rating and dimensions as specified in **Part 3** of this specification and indicated in the schedules and drawings.

Convectors shall have a rated output in accordance with BS 3528.

Convectors are to be fabricated from mild steel sheet with front panel and top rail of 1.2mm minimum thickness and a backplate, where specified to be of 1.2mm minimum thickness, lengths not exceeding 2400mm, to be removable yet secure in normal use.

2.3 HEAT EMITTERS

Where specified in **Part 3** and on the drawings and schedules, provision shall be made as detailed for removable partitions to finish up against the convectors without restricting the removal of the casing. Acoustic baffles shall be provided in casing on partition line.

Heaters for low and medium temperature hot water heating shall be the finned tube convection type enclosed in sheet steel casing unless otherwise specified. Finned tube elements shall comprise aluminium alloy fins mechanically bonded to solid drawn copper tube. Copper tubing element ends shall conform to BS 2871:Part 1 and adjoining sections shall be interconnected with tubing of the same grade and diameter. Tube connections shall be of the capillary or compression type unless otherwise specified. The element to be tested at Manufacturer's work to a test pressure of 20 bar/2000kPa or twice the working pressure specified, whichever is the greater.

The completed installation shall present a perimeter convector of a continuous unbroken appearance. The units shall be suitable for being supported from brackets directly fixed to the wall. The fixing brackets should enable easy adjustment to permit accurate levelling after the initial fixing. Elements and heating pipework located within the casing shall be supported independently from the casing. Casing front plates shall incorporate all necessary baffling to prevent air by-passing the elements.

The casing system shall incorporate all necessary special sections to take the convector around internal and external corners, and shall incorporate valve boxes with easily removable access covers, end stops and hand operated dampers to be provided where specified in **Part 3**.

Convector front plates shall be constructed from a minimum of 1.2mm thickness sheet steel and be of rigid and robust construction.

All necessary expansion bellows, pipe guides and anchors shall be provided. Control dampers shall be capable of controlling the convector emission down to 25% of the maximum rated output. Damper control shall be easily operated but unobtrusive. Convector grilles shall be located on top or front of the casings as indicated in the schedules and on the drawings. Grilles shall be, unless otherwise indicated, to the Manufacturer's standard and be of neat appearance.

Casings shall be delivered to site with two coats factory applied primer for finishing on site by others, or to Manufacturer's standard finish to a defined colour as defined in the schedules and in **Part 3**.

The convectors shall be fitted with thermal insulation behind the backplate, on external walls, where specified, suitably sealed behind the unit casing in contact with the wall surface and protected from damage after installation and the casing interior thoroughly cleaned and element fins combed prior to commissioning.

Isolation and regulation valves shall be provided for commissioning and maintenance.

FAN CONVECTORS

Fan convectors shall be of the type, rating and dimensions as specified in **Part 3** of this specification and as indicated in the schedules and on the drawings. The thermal output and performance specified being determined in accordance with BS 4856:Part 1, Part 3 (where applicable) and Part 4.

They shall be floor, wall or recessed mounting pattern, with louvred grilles and damper control as indicated on the schedules and in **Part 3**.

The casings to be fabricated from mild steel sheet of 1.2mm minimum thickness, with removable front panel for access and for maintenance.

2.3 HEAT EMITTERS

Suitable stiffening is to be applied and metal parts in close contact are to be fixed to prevent chatter. Where specified, the casing interior is to be lined with flame retardant, non-migrating, acoustic insulation. The casing shall be completely de-rusted and finished with two coats of primer paint before leaving Manufacturer's works for final finish on site by others or to a finish indicated in the schedules.

The heating elements shall comprise solid drawn copper tubes expanded into close metallic contact with aluminium plate fins. The tubes shall be brazed into steel or cast bronze headers, having BSPT female connections. Space shall be allowed within the convector casings for regulating and isolating valves. Heating elements shall be fitted with air vents. The element to be hydraulically tested at Manufacturer's works to a pressure of 20 bar/2000kPa or twice the working pressure, whichever is the greater.

The units shall be fitted with air vents positioned to ensure complete evacuation of air, and be easily accessible.

The fans and motors shall be mounted on a deck independent of the convector casings.

Anti-vibration mountings shall be provided where necessary or where specified to minimise fan and motor vibration. The motor shall be positioned for easy maintenance.

Each convector shall have its individual isolating and regulating valves and where called for space shall be allowed for these within the casing.

Fans shall be of the forward curved centrifugal quiet running type both statically and dynamically balanced. Motors shall be totally enclosed, fan cooled to BS 5000:Part 11, Class E insulated, suitable for single phase operation with bearings sealed for life and requiring no routine maintenance and be complete with internal wiring to built in controls and low limit thermostats or other external controls as specified.

The sound pressure level within the space served by the fan convectors shall normally be achieved with the units running at low speed unless otherwise specified in **Part 3**. The motor shall be provided with a 3-speed controller.

Either a washable type flame retardant air filter, having a minimum efficiency of 60% when using No. 2 Test Dust to BS 6450 (EU2) shall be fitted or a mesh galvanised wire filter as defined in **Part 3**.

The convectors shall be suitably sealed, behind the unit in open contact with the wall surface and protected from damage after installation and the casing interior thoroughly cleaned, clean filter fitted and element fins combed prior to commissioning.

Where specified in **Part 3** or on the schedules, a fresh air inlet shall be provided at the rear of the unit complete with hand operated or motorised damper, for providing full or part recirculation of air.

Where fresh air inlets or cold air are available, use low temperature cut outs.

UNIT HEATERS

Unit heaters shall be of the type, rating and dimensions as defined in **Part 3** of this specification, and as indicated in the schedules and drawings.

The Manufacturer's thermal and volumetric output and acoustic performance tests shall be as determined in accordance with BS 4856:Part 1, Part 3 (where applicable) and Part 4.

The sound pressure level within the space defined in **Part 3** served by the unit heaters shall be achieved by the correct selection of a suitable motor running speed.

2.3 HEAT EMITTERS

Casings shall be manufactured from 1.6mm thickness mild steel minimum and arranged to protect the coil, fan, motor and all moving parts. Vertical discharge units shall have extended discharge cowls and adjustable diffusers, horizontal units shall be fitted with a set of adjustable horizontal louvres. Casings shall be fitted with suitable suspension cleats or similar so arranged as to ensure that the heater will hang plumb when freely suspended. Exposed moving parts shall be enclosed with heavy gauge wire guards. The whole de-rusted and treated with one coat of primer paint or factory finished as specified.

LTHW and MTHW or steam heating elements as specified in **Part 3** shall comprise solid drawn copper tubes expanded into close metallic contact with aluminium plate type finning. The tubes shall be brazed into steel or bronze headers. Headers shall have air vents extended to the outside of the unit casing and a drain cock shall be provided.

Flanged connections shall be provided where specified in the schedules and in **Part 3**.

A low temperature water thermostat shall be provided to cut out the fan at low water temperature. The minimum air off temperature shall be 40°C.

The units shall be subjected to a hydraulic test pressure of 20 bar/2000kPa at Manufacturer's works, or twice the working pressure specified, whichever is the greater.

The unit shall have statically and dynamically balanced fans of the rotor motor type or propeller type, robustly constructed and securely fixed. Fan speeds not to exceed 25 rev/s unless otherwise specified. The unit shall have a totally enclosed motor together with starter, isolator and control devices. Motor to be resiliently mounted on anti-vibration mountings on the unit casing.

Motors shall be totally enclosed to IP55 per UNE 20-111 and CEI 34.5, windings Class F. Motors shall have sealed for life bearings requiring no maintenance, 3-phase motors being of the squirrel cage induction type. Single phase motors may be either split phase or permanent capacitor type with the capacitor mounted in a position where it is protected from the heating apparatus.

The unit shall have brackets for supporting from the building structure in the position shown on the drawing and specified in **Part 3** and have an identification plate showing:-

- Manufacturer's name and address.
- Serial number.
- Duty.
- Electrical loading.

Each unit shall have its individual isolating and regulating valves.

AIR CURTAINS

Air curtains shall be of the type, rating and dimensions indicated in the schedules and in **Part 3** and shall be installed to serve at least the full width of opening to provide an effective barrier between internal and external environment, arranged to provide horizontal/vertical air flow as defined. The sound level shall be suitable for the area served as defined in **Part 3**.

Unit Casing

The casing shall be manufactured from a minimum of 1.2mm thickness zinc plated mild steel and shall be complete with inspection panels. Finish shall be to factory standard unless otherwise specified.

Inlet Grille

A fixed blade inlet grille shall be provided with material and finish etc. as specified elsewhere.

2.3 HEAT EMITTERS

Air Outlet Assembly

The outlet shall be constructed of a stiffened zinc plated steel frame with 50mm minimum deep aluminium blades.

Air Filter

An air filter shall be fitted behind the air inlet grille where specified and shall be easily accessible for cleaning.

Air Heating Coil/Battery

The heating coil/battery shall be LTHW, MTHW or electric as defined elsewhere in this Specification.

Water Heating Coil

Water heating coils shall have aluminium fins mechanically bonded on to copper tubes. Each coil shall be hydraulically tested at works to a pressure of 20 bar/2000kPa or twice the working pressure specified, whichever is the greater.

The heating coil shall be supplied with water side controls, control valves and temperature sensor. Regulating and isolating valves shall be provided.

Electric Heater Batteries

The electric heater batteries shall be constructed from stainless steel elements fitted within copper tubes onto which are mechanically bonded aluminium fins. The battery shall have a minimum of two settings, 50% and 100%, and shall be provided with a high temperature cut-out and a built-in safety control thermostat which can be used to maintain variable outlet temperature where specified. The controls shall be designed such that, for safety reasons, after switching off, the fan shall remain running until the heater battery has cooled.

Fans

The fan shall be double inlet centrifugal direct driven with sealed for life bearings. The fan and motor assembly shall be easily accessible and removable. The fan scroll and impeller shall be manufactured from zinc coated steel. The fan and motor shall be on resilient mountings.

An integral step transformer shall give the facility for 3-speed selections.

Each motor shall be provided with thermal contact protection integral to the motor windings to provide automatic cut-off when the maximum permitted motor temperature is exceeded.

Cable entry bushes shall be provided in the unit with access to the terminal block via an inspection panel.

Control Units

A wall mounted control unit shall be provided suitable for individual or group control with setting for off and low, medium and high fan speeds with a neon indicator light.

Electric heating units shall have additional switches for heat output control with off, low and high positions where necessary or specified.

Finish

The unit shall be finished to the Manufacturer's standard paint finish, unless otherwise specified.

2.3 HEAT EMITTERS

OVERDOOR HEATERS

Overdoor heaters shall be suitable for overdoor or wall mounting and shall be of the full recirculating type, consisting of a centrifugal fan, electric on LPHW heating coil, combined within a sheet steel casing and arranged for remote control and switching of the fan.

The centrifugal fan shall comprise a forward curved impeller contained within a galvanised sheet steel fan scroll and mounted on a steel shaft directly driven by an electric motor. Finish shall be as indicated on the schedules and in **Part 3**.

Units shall fully comply with the appropriate British Standard and shall be provided with the necessary safety devices. Where controls and switchgear are supplied in a panel they shall comply with BS 5486.

All water heaters shall be provided with a low water temperature stop/start thermostat.

The overdoor heaters shall be supplied complete with all necessary controls.

The sound power level shall be suitable for the area served as defined in **Part 3**.

RADIANT PANELS

Radiant panels shall be of the type, rating and dimensions as specified in **Part 3** of this specification and indicated in the schedules and drawings.

Water or Steam

The tube and plate radiant heater panels suitable for steam/MTHW/LTHW application as defined in the schedules and in **Part 3**, shall be constructed in accordance with relevant British Standards. Tube and plate assembly shall ensure efficient heat transfer to maximise effective radiant surface area.

Where required, the radiant heater installation shall form a continuous appearance for each circuit as indicated on the drawings.

Each circuit shall be installed with air vents, isolating valves on flow and return and drain down cock. Closing plates shall be installed between individual panel sections to facilitate continuous appearance.

Each radiant panel shall incorporate jointing provisions screwed BSPT/victaulic groove/weld prepared with tube construction suitable for working and test pressures as defined in the schedules and in **Part 3**.

Radiant panels shall:-

- have surface plates smooth and free from distortion, sealed where connections pass through the sides of each panel and between the edges of each panel and the wall or ceiling surface. Plates being flush or curved edge.
- be provided with purpose made hangers, the points of support being to the Manufacturer's recommendations.
- have thermal insulation, as specified, incorporated between the face plate and back cover plate where fixed to walls or ceilings.
- have flush type key operated air vent plug or cock fitted at the highest point of wall mounted panels. Ceiling panels are to be vented.

2.3 HEAT EMITTERS

- be completely de-rusted and coated at factory with primer paint final. Finish as defined in the schedules, except where site applied, aluminium or polished stainless steel is specified.

CEILING HEATING

Ceiling heating shall be of the type, rating and dimensions specified in **Part 3** of this specification and indicated on the schedules and drawings and be capable of acoustic performance, where specified, determined in accordance with BS EN 20354.

To be provided with plain or perforated panels, as specified, of zinc coated mild steel or aluminium spray painted finish. The panels to include fittings, and be complete with edge trims and hinge panels where shown on the drawings.

To be suspended, by corrosion protected hangers, arranged for accurate levelling of the ceiling and coils.

The coils shall be either steel or copper as defined in **Part 3**.

Heating coils shall be of heavy weight mild steel to BS 1387 with welded joints hydraulically tested to 7 bar and further checked by blowing a steel ball through the completed coils to confirm unrestricted bore. Coils to terminate in heavy weight mild steel flow and return headers. Coils to be treated after fabrication for rust prevention.

Coils manufactured from copper tube shall have soldered joints and terminating in copper headers.

To have minimum of 25mm thick enclosed mineral insulation mattress, laid over the heating coils and returned to form a good thermal acoustic seal with the panel, and terminating clear of lighting fittings.

To be provided with manual or automatic air venting as defined in **Part 3**.

UNDER FLOOR HEATING

Under floor heating shall be of the type and rating defined in **Part 3** of the specification and as indicated on the schedules.

Electrical Under Floor Heating

Electric resistance wire or electric heating mats shall be used as defined in **Part 3** and they shall be securely fixed and arranged to ensure even distribution throughout the area. Cold tails shall be provided to terminate each individual circuit.

LTHW Heating

LTHW pipework shall be either cross-bonded polyethylene or continuous copper tube or a proven industry standard material as defined in **Part 3**.

Cross-bonded polyethylene pipework shall be installed without joints under the screed. Flow and return connections to each loop shall be connected to the LTHW heating system via purpose made manifolds.

General

The under floor heating system shall be installed strictly in accordance with the Supplier's recommended procedure.

Floor preparation, insulation and enclosing screed shall be provided by others which shall be to the Manufacturer's recommendations.

2.4 AIR HANDLING EQUIPMENT

GENERAL

Packaged supply and extract air handling plants shall be provided as defined in the schedule of equipment and as indicated on the drawings and as defined further in **Part 3** of this specification.

This particular section of the specification describes the requirements for the construction of the body of the air handling unit and the provisions to be made for the particular equipment to be provided within the unit.

The items of equipment that may be selected for including within the air handling plant for the particular application are described under their respective headings in the following sections of Part 2 of this specification, and defined in particular in **Part 3** and in the schedules.

Plants shall be of a rigid, air tight, assembly and constructed in unitary form or consist of standard modular components, assembled to ensure even air flow throughout plant with no by-passing of active components.

Sealing strips shall be provided between all component parts. Factory joints shall be fully tightened and all necessary sealing strips, nuts, bolts and washers etc. being provided for site made joints.

Panels penetrated by service pipes, electrical cables etc. shall be sealed together with all joints having an air leakage integrity at design pressure which is not less than the integrity of the associated ductwork systems.

The units shall incorporate gradual change section pieces between sections to minimise pressure drops, with spacing of components to Manufacturer's recommendations to ensure satisfactory operation at each stage and allow access for inspection, cleaning and maintenance.

The inside surfaces shall have smooth and easy clean finishes free from structural projection.

The location of fan motor, fan belts and filter motor inside or outside air stream shall be as defined in the schedules and on the drawings and in **Part 3**.

All modular constructed plants shall be provided with purpose made base frames which together with builderswork bases shall be of sufficient height to accommodate drainage traps from dehumidifiers, humidifiers etc.

All plants shall be provided with sufficient access panels/doors and viewing windows to allow maintenance and repairs to be carried out. On larger plants or when maintenance space is restricted, split/multiple coils shall be used.

Construction shall be such as to withstand maximum fan static pressure without deformation and with panel deflection of not more than 1/120 of maximum panel dimension under operating conditions.

Frame work shall be strong enough to suit the application, location and size of the unit to prevent distortion during transportation and suit the engineering requirements.

Where units incorporate humidifying plant, recuperators or cooling coils, the internal surfaces of the units liable to be affected by any free water produced shall be protected by anti-corrosion paint (white) or a similar finish. Such units shall have adequate drain trays to collect water; the drain trays shall be extended, or other means of collection shall be provided to ensure the removal of any water deposited or condensed in adjacent sections.

Trays collecting cooled water shall be insulated to prevent condensation on the outer surface. All the surfaces/features shall be suitable to withstand regular cleaning with a water solution containing 5ppm chlorine.

Internal sloping surfaces for humidifier and cooling coil sections to fall to drain.

All drains shall be provided with glass U-traps suitable to withstand twice the negative/positive pressure produced by the fan and have a screwed access for cleaning and filling as indicated in TM13 and as further defined in **Part 3** and Department of Health Guidance Notes.

All units shall have lifting lugs or marked lifting positions.

2.4 AIR HANDLING EQUIPMENT

The completed units or part units shall be suitably protected during delivery and prior to incorporation into the works, to minimise mechanical and atmospheric damage with all open ends being sealed.

All plants shall be tested by the Manufacturer at works and on site after assembly.

Certified type test performance certificates shall be issued to the Engineer on completion of plant testing for fans, coils, filters and electric motors etc.

Fire rating type test certificates shall be provided for filters.

Individual pressure testing certificates shall be provided for coils.

All wiring from fans and other electrical equipment in the air handling unit shall be terminated at an external terminal box fixed to the unit.

External load breaking fault making isolating switches shall be provided to each drive to isolate all poles of the electrical supply.

Where internal lights are specified in **Part 3**, these shall be bulkhead tungsten (with fluorescent on larger units) and of sufficient number to provide lighting of space for general inspection and maintenance, these shall be wired back in screwed steel conduit by the unit Manufacturer to the externally unit mounted terminal box. The wiring shall comply with the latest edition of BS 7671. The lights shall switch externally from the units.

DUTIES

The plant duties listed in the equipment schedules and **Part 3** are the design values and plant selection shall be such that these can be achieved when fully assembled and operating under site operating conditions.

The plant shall be selected to meet the noise criteria specified in the schedules.

CONSTRUCTION

Packaged air handling plants shall be suitable for internal or external installation, as defined in the schedules and in **Part 3** of this specification and, in particular, be suitable for the geographical location and the local temperature, humidity or corrosive conditions in which the air handling unit is located. This shall apply in particular to locations in coastal areas, industrial areas and other areas where there is a level of pollution that may cause damage to the unit casing or the equipment contained therein.

All units shall be of double skinned construction unless otherwise specified in **Part 3**. The double skin panels shall be a minimum of 25mm nominal thickness with metal sheet of not less than 1.0mm thickness and insulation infill of thermal conductivity not more than 0.04W/m².

The units shall be constructed from materials as defined in the schedules and **Part 3** of this specification.

Where maintenance must be carried out from within, units shall have floors suitably supported to withstand the weight of two men and equipment, irrespective of the construction type specified and shall have chequer plate or foam filled floor panels.

2.4 AIR HANDLING EQUIPMENT

EXTERNAL UNITS

Units intended for external installation shall be of double skin coldbridge free construction and shall be sealed with a suitable mastic sealant around all section joints, prior to painting.

Suitable gutters and down pipes shall be provided to suit the application, where applicable.

INSULATION

Insulation materials shall perform the following functions:-

- Thermal Insulation.
- Acoustic Treatment.
- Structural Treatment.

Lining/insulation materials shall comply to BS 476:Parts 6 and 7, meet with Local Authority Approval and be suitable for the application.

Thermal insulation shall be securely fixed to all sections handling heated or cooled air; where appropriate it shall include a vapour seal. Where thermal (or acoustic) insulation is fitted internally, it shall be securely fixed and shall be properly protected to prevent migration of fibres into air stream. In areas where there may be free moisture or condensation, the insulation shall have surface protection to prevent waterlogging.

FINISHES

All internal and external air handling plants shall be externally finished to the standard defined in the schedules or **Part 3**.

ACCESS

Access doors/hatches as appropriate and where indicated on the drawings or called for in **Part 3** shall be provided complete with handles, locks, keys and latches to the same standards of construction and finish of unit. Where the unit is large enough for a Maintenance Engineer to enter the unit, facilities for local maintenance isolation of equipment and opening the doors from the inside shall be provided.

All doors/panels shall be provided with seals to prevent air leakage.

Access shall be provided as a minimum to fan chamber, dampers, filters, humidifiers and both sides of heating and cooling coils and run around coils.

Additionally, the cladding shall be capable of being easily removed as is necessary to obtain access for necessary inspection and maintenance and also for removal of large items of equipment. All necessary items shall be assembled by means of nuts, bolts, anti-vibration lockwashers or approved quick release fastenings.

ACCESSORIES/COMPONENTS

The following component parts and accessories shall be provided as defined on air handling plant schedules and drawings:-

Fan Section

The fan and motor sets shall be as defined in the schedules and as described in the fans section of this specification.

The fan chambers shall be of sufficient size to accommodate the selected fan type, motors, drives, guards and control devices with strengthened frame work as required to support fan/s and drive arrangements.

Fan/s and drive/s shall be provided with mounting frames and isolation mountings. Motors shall be located either within fan chamber or externally as specified in the schedules. On externally driven fans where specified,

2.4 AIR HANDLING EQUIPMENT

drive connection or belts shall be provided with air tight seals to prevent leakage. Externally driven fans shall have suitable anti-vibration mountings and frame with flexible connections to the fan sections of the unit.

Flexible connections suitable for the application and in accordance with Statutory Authority requirements, shall be provided between fan discharge and casing in accordance with Statutory Authority requirements and BS 476: Part 7.

Fan discharge diffusion chambers shall be provided to all blow through units.

Suitable guards shall be provided to all accessible drive belts and open fan inlets or discharges. Drive guards shall be provided with tachometer access to fan and motor shafts. Access door/s panels shall be provided to allow for both general maintenance and removal and replacement of largest component.

Filters

Filters shall be as defined in the schedules and as described in the filter section of this specification.

Filters may be provided in separate plant section of the air handling unit or, if specified, as part of a common section. Filter banks shall be provided with mounting frames to suit standard commercially available filter cells, arranged for side or front withdrawal as per schedules.

Manometers or magnahelic gauges shall be provided across each filter bank including differential pressure switching as detailed in **Part 3**.

Access doors or panels shall be provided to allow removal and replacement of filters.

For number of spare filter cells to be provided, see spares section of this specification.

Where electrostatic filters are required, access door/electrical interlocks and warning signs shall be provided.

Coils

Frost coils, heater coils and cooling coils shall be provided, as defined in the schedules and as described later under the coil section of this specification.

Slide rails shall be provided where necessary to allow coils to be removed.

Heat Recovery

Heat recovery devices shall be provided, where specified, as defined on schedules and as described later in the heat recovery section of this specification.

Humidifiers

Humidifiers shall be provided, where specified, as defined in the schedules and as detailed later in the humidification section of this specification.

Humidifier sections where required shall be provided with eliminators or be of sufficient length to allow full mixing of vapour with air stream to avoid migration of water droplets to other sections.

Internal casing panels shall be treated and suitably finished to avoid deterioration of materials and finishes.

Drain pans and drains shall be provided.

Sound Attenuators

2.4 AIR HANDLING EQUIPMENT

Where specified, in the schedules and in **Part 3**, sound attenuators internal or external to the air handling units shall be provided to meet the requirements of the sound attenuator section of this specification.

Attenuators shall be to the same cross section area as the air handling plant and provided with inlet/outlet diffusion plenums as necessary.

Dampers

Inlet/outlet and mixing dampers shall be provided as specified and as indicated on schedules and drawings. Inlet/mixing dampers shall be parallel blade type, outlet and throttling/shut-off dampers shall be opposed blade type. All dampers should be sized with appropriate control authority and fitted with resistance grids as necessary.

Motorised dampers, linkages and motors shall be provided by the AHU Manufacturer, unless otherwise stated in this specification.

Mixing and throttling dampers shall be sized to provide adequate control over the full movement of the dampers, giving near linear characteristics without incurring high pressure drops.

Rotation angle of damper motor spindle shall, where possible, correspond with the required operating angle of the damper to which it is connected.

All fresh air dampers shall be provided with end switches suitable for nominally 230V, ac 50 Hz and be of 2 Amp rating, unless otherwise specified.

All actuators shall be capable of operating from a nominally 230V, 50Hz electrical supply. All modulating dampers shall be suitable for 0-10V control operation, unless otherwise specified.

Where required, actuators shall be fitted with adjustable angle of rotation limiters, which shall be capable of limiting both the maximum open and closed position. Where auxiliary switches are fitted to these actuators, they shall operate at the point of limited rotation.

All dampers shall be provided with manual operation provisions.

Dampers for VAV systems shall be sized (with additional physical resistance introduced at the unit dampers where necessary) to ensure that under all volumes of the fan from maximum to minimum the fresh air volume cannot fall below the design minimum volume unless the controls override to shut the fresh air damper.

Louvres

Inlet/outlet louvres where required shall cover the full face of unit and be provided with bird/vermin screens. Inlet louvres shall be fitted with rain eliminators.

2.5 COILS & BATTERIES FOR HEATING & COOLING

GENERAL

Air heater and cooler coils/batteries shall be provided in air handling plants and/or for duct mounting as specified in the schedules and **Part 3** of this specification.

Coils shall be designed to meet the outputs specified, at the indicated primary air and heating/cooling medium conditions within the limitations of velocity, resistance and sizes specified.

They shall be of the type, material and manufacture suitable for the heating or cooling medium to be used.

All water batteries shall be designed to ensure equal flow through all circuits and arrange for contra-flow with water entering at air leaving end. The water flow and return connections together with the air flow direction shall be permanently marked on the casing. All coils shall be supplied complete with vents and drains.

Provision shall be made for expansion of the tubes and for effective venting of the coils. Coils shall be arranged so as to facilitate removal of the coils without draining local pipework and appropriate airtight cover boxes shall be provided over the headers and bends where these are external.

On large coils, multiple or split coils shall be used to ease installation, repair and maintenance operations. Cooling coils shall be of eight rows maximum depth unless specified otherwise with sealing plates being provided in split/multiple coils to prevent air by-pass.

Heat exchanger finned surfaces shall extend the full width of the coil casing. Coils shall be suitably protected against corrosion with due regard to the geographical location of the coil and local atmospheric conditions. Sealing devices shall be provided around the casing to prevent air by-pass and water carry-over.

Fins shall make firm and continuous contact with tubes. Where more than one row of tubes are provided, rows shall be staggered to maximise heat transfer and provide even air distribution across the face of the coil.

Copper and cupro-nickel tubes shall comply with BS 2871:Parts 1, 2 or 3, according to duty, mild steel tubes to BS 1387.

Electro-tinning when specified in schedules for copper tube and copper finned coils shall comply with the requirements of BS 1872.

Casings shall be galvanised sheet steel not less than 1.2mm thick with angle framing at each end drilled ready to receive the counter flanges on the connecting ductwork. Coils shall be supported so that their weight is not transmitted to ductwork and so they can be removed without disturbing adjacent ductwork. Inspection doors shall be provided on both the upstream and the downstream sides of the coils.

Headers and return bends located outside of the casing shall be provided with insulated, gasketed air tight removable covers. Insulation shall be a minimum of 19mm thick or as otherwise specified to prevent condensation on the casing and to minimise heat gains and losses.

Primary water connections to headers shall be terminated 100mm clear of covers or casing, being screwed with union connections to BS 21 up to and including 50mm and flanged to BS 4504 to 65mm and above for use on LTHW, MTHW and chilled water applications unless otherwise specified. All connections to HTHW and steam coils shall be flanged to BS 4504.

All coils shall be provided with air vents and drains.

All coils shall be tested at the Manufacturer's works or an approved testing laboratory and rated for thermal performance to BS 5141:Part 1 or Part 2 and certificates provided.

All coils shall be tested at the Manufacturer's works for pressure soundness to 1.5 x working pressure or 20 bar g whichever is greater and certificates provided. Coils shall also be provided with identification plate giving Manufacturer's name, serial no., duty, maximum working pressure, test pressure and operating design temperatures.

2.5 COILS & BATTERIES FOR HEATING & COOLING

HOT WATER HEATING COILS

The low temperature hot water coil tubes and fins shall be constructed from one of the following material combinations as scheduled later in this specification:-

- Copper tubes with aluminium or copper fins with copper or steel headers.
- Mild steel tubes with mild steel fins and steel headers all being protected against corrosion.
- Cupro-nickel tubes with aluminium or copper fins with cupro-nickel or steel headers.

Heat exchangers shall be arranged, unless otherwise specified, with horizontal tubes and vertical fins and headers. Tube thickness and construction shall be suitable for the system operating temperatures and pressures and terminated in one pair of tubular headers to each coil or section.

Resistance to air flow through the coil shall not exceed 65 Pa with a face velocity not exceeding 4.0m/s.

Anti-frost coils shall have plain tubes or be provided with widely spaced fins at not less than 6mm pitch and shall offer minimal resistance to air flow while achieving the required heat transfer.

ELECTRIC HEATER BATTERIES

Electric heater batteries shall consist of a number of enclosed black heat elements mounted in a sheet steel casing. The number of elements shall be the same as or a multiple of the number of control steps specified, with elements arranged to permit removal without dismantling of adjacent ductwork or plant.

All heaters and heater sections of more than 3kW loading shall be balanced over three phases and the complete heater bank shall be arranged for balanced operation on a 3-phase, 4-wire system.

Connections from each element/heater sections shall be extended to a suitable terminal box/isolator housed in an accessible position on the heater casing. Each heater section shall be separately fitted with a protective device and the neutral point for all 3-phase star-connected sections brought out to a link in the terminal box/isolator.

Surface temperature of the elements shall not exceed 400°C when measured in an air flow of 2.5m/s at ambient temperature. Electrical wiring insulation shall be suitable for the maximum expected temperature in hot areas.

A sensor shall be provided to sense high temperature which shall, through the control system, provide an out of condition alarm at a remote location.

Batteries shall be provided with a manual reset thermal safety cut-out to provide an audible or visual alarm signal on high temperature indication, the sensor being nearest to and above the initially energised elements.

STEAM HEATER COILS

Steam heater coils construction and tube thickness shall be suitable for the system operating pressure and temperature. Coils operating in excess of 10 Bar gauge pressure or 200°C shall have tubes and headers of cupro-nickel. All coils shall be fitted with vacuum breakers.

Anti-frost steam heater coils shall have tube within tubes to distribute steam evenly throughout the host tubes to ensure that condensate will not freeze.

Maximum face velocity 4.0m/s - maximum resistance to airflow 65Pa.

Coils shall be of vertical tube type, self-draining.

CHILLED WATER COILS

2.5 COILS & BATTERIES FOR HEATING & COOLING

Chiller water cooler coils shall be constructed from one of the following material combinations as specified in the schedules later in the specification:-

- Copper tubes with aluminium fins and copper or steel headers.
- Copper tubes with copper fins and copper or steel headers.
- Tinned copper tubes with aluminium fins and copper or steel headers.
- Copper tubes and fins electro-tinned in block form after assembly with copper or steel headers.
- Cupro-nickel tubes with aluminium fins or copper fins block electro-tinned after assembly with cupro-nickel or steel headers.

Heat exchangers shall have horizontal tubes with vertical fins and headers. The bottom of casings shall be made in the form of a water tight stainless steel drain tray being sloped towards a flush drain connection such that no water is retained in the tray. Intermediate drain trays shall be provided to all coils exceeding 1 metre in height, i.e.:-

Coils up to 1 metre high	-	1 No. tray
Up to 2 metres high	-	2 No. trays
Up to 3 metres high	-	3 No. trays
Up to 4 metres high	-	4 No. trays

Trays shall be arranged to drain to one end, then via down pipe/s without splashing to bottom tray. Down pipes and drain shall be sized to clear condensate produced during cooling process without backing up, to ensure tray/s are fully drained during operating periods.

Eliminators, where required to avoid water carry over into downstream air shall be positioned to avoid damage from adjacent heater batteries and be manufactured from heat resistant materials. Drain trays to coils shall be extended or separate trays shall be provided to collect water from the eliminator.

Coils shall be designed to achieve the specified duties and requirements with face velocities not exceeding 2.5m/s and point velocities not exceeding 3.0m/s with an air flow resistance through coil and eliminators not exceeding 250 Pa under wet coil conditions, manufactured from materials that are able to withstand external cleaning with a water solution containing 5ppm chlorine.

Coils shall be provided with access doors complete with viewing windows upstream and downstream designed to afford easy access for inspection and cleaning.

Coils shall be manufactured from materials that will not support microbiological growth; this includes surface finish mastics, gaskets, insulation, sealants etc. This applies to both coils and drip trays. The Water Fittings Directory lists suitable materials.

All cooling coils shall be provided with a glass trap in accordance with CIBSE TM13 and Department of Health Guidance Notes.

DIRECT EXPANSION COOLING COILS

Direct expansion refrigerant cooler coils shall be constructed from one of the following material combinations as specified in **Part 3**:-

- Tinned copper tube with aluminium fins and copper headers.
- Copper tubes and fins electro-tinned in block form after assembly with copper headers.

Coils shall be constructed in a similar manner and requirements to those for chilled water coils with respect to drain trays and eliminators.

2.5 COILS & BATTERIES FOR HEATING & COOLING

Inlet liquid distributors and return suction headers shall be provided and arranged to ensure even distribution of refrigerant to all circuits and the return of oil to the compressor. Circuits shall be fully interlaced to ensure even air temperature across full face of the coil. Liquid distributors, return suction headers and return bends shall be located out of the air stream.

Coils shall be solid drawn copper coil made from tube to BS 2871:Parts 1, 2 or 3, according to duty with refrigerant tube degreased and dehydrated internally. Coils for DX systems to be made from refrigerant grade copper.

Maximum face velocity 2.8m/s - maximum resistance 250Pa coil and eliminator.

Each direct-expansion coil shall be works tested for leaks by using air under water to 19 Bar gauge pressure for 30 minutes. On satisfactory completion of all Manufacturer's works tests, coils shall be dehydrated, charged with a dry inert gas and sealed.

All of the coils shall be designed and matched to the specified refrigeration machine and condenser package to meet the requirements of this specification.

There shall be liaison between the Coil Supplier and the Refrigeration Machine Manufacturer to ensure the match of equipment. The refrigeration machine shall be installed to meet the safety requirements of BS 4434, if refrigerant cooled.

2.6 FANS

GENERAL

Fans shall be provided in the air handling units or for independent installation, as specified in the schedules of plant and equipment and Part 3 and shall be complete with all accessories, control devices and be suitable for the application. Fans provided in air handling units shall additionally comply with requirements of the air handling unit section of this specification.

The plant volumes and resistances quoted in the schedules are the minimum design values. The external resistance value given in schedules for air handling plants is the system resistance only and does not include for filters, coils, attenuator, guide vanes etc.

Fans shall be selected such that the operating point on a constant speed pressure/volume curve provides stable efficient operation.

Fans shall be capable of giving the aerodynamic and acoustic performance specified when related to the required application and the relationship of air inlet, air outlet, ducted or free configuration, as standardised under installation Categories A, B, C and D to BS 848:Part 1:Clause 17.2 and BS 848:Part 2. Performance and noise data shall be provided based on type testing at the Manufacturer's works or an approved testing laboratory.

Where fans are supplied with integral noise attenuators, full details of the construction and performance of the attenuators shall be provided.

Belt driven fans shall be fitted with pulleys suitable for V-belts; pulleys of the taper lock type may be used for drives up to 30kW output. Alternatively, and in any case above 30kW output, pulleys shall be secured to the fan and the motor shafts by keys fitted into machine keyways. Keys shall be easily accessible so that they can be withdrawn or tightened and they shall be accurately fitted so that any gib head does not protrude beyond the end of the shaft.

Belt driven fans shall have a minimum of two drive belts to BS 3790 with provision for alignment and belt tensioning, with fan and motor on a common base. Shaft and impeller assemblies of all fans shall be statically and dynamically balanced to BS 6861:Part 1 with vibration severity in accordance with BS 4675:Part 1 (or BS 848:Part 7 in course of preparation).

Fan bearings shall be of a type suitable for the size, speed, loads, fan angle and operating conditions. Bearing housings shall be protected against ingress of dust and be precision aligned or self-aligning such that bearings may be replaced without need for re-alignment.

The fan bearings shall be designed for an L¹⁰ life of not less than 40,000 hours in accordance with BS 5512 or ISO 281 at the duty flow rate, pressure and rotational speed. The Manufacturer shall provide in his calculations for the axial and radial loadings due to the effects of thrust, impeller and shaft weight and V-belt pull and shall state the actual calculated life achieved.

Suitable guards to BS 5304 and BS 848:Part 5 shall be provided to all rotating, moving components, non-ducted fan inlets and outlets and for open unprotected intakes and exhausts from axial flow fans; for open and unprotected and easily accessible intakes to, and exhausts from, propeller fans; for V-belt drives; for drive couplings and elsewhere as indicated.

Guards shall be readily removable to permit belts to be changed. Adequate access panels shall be provided in the side of guards to allow tachometer readings of the two shafts to be taken and belt tension to be tested. Allowance shall be made in the dimensions of the guard and the size and position of access panels for the adjustment of the motor on its slide rails.

2.6 FANS

Where duplicate motors are called for in the schedules and fixed for fans, the spare motor shall be complete with slide rails and be fixed in position ready for operation. The guard provided shall be either a double guard or a single guard specially designed to protect both directions of the drive. All fixings and mountings for both positions shall be supplied and fitted and changeover of the guard and drive shall be simple and quick.

Fan casings shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during operation.

Casings, impellers, shafts, motors etc. shall be protected against corrosion and deterioration of finishes from both the handled gases and the installed environment.

Fans shall be provided with protective finishes as necessary for the service conditions specified and free of damage to the protection when installed.

Anti-vibration mountings shall be provided where specified and shall be designed to give not less than 90% isolation.

All nuts, bolts, set screws and washers shall be Grade 8.8 to BS 4190. Holding down bolts for fans and motors shall be square section under the head or be fitted with snugs to prevent them turning in the fan baseplate when the nuts are tightened. Any fan or section which is too large or too heavy for safe man-handling shall be provided with eyebolts or other lifting facilities to enable mechanical lifting equipment to be used.

Motor nameplate power rating shall allow a margin for 10% increase in fan flow rate on the selected performance curve and shall also allow for a 20% increase in fan generated head through fitting a larger impeller or through a pulley drive speed increase.

CENTRIFUGAL FANS

Centrifugal fans shall be of the backward or forward curved type as specified on schedules or data sheets. Unless otherwise indicated, fans consuming more than 7.5kW at fan shaft shall be of the backward curve type irrespective of required static pressure; and having fan total efficiency at the duty point of not less than 75%.

Casings shall be constructed from galvanised mild sheet steel with welded lock formed or riveted joints to suit application and welded angle stiffeners and base angles to ensure freedom from drumming and shall be suitable for operation at the maximum static pressure of the system. Fan casings shall be constructed so that impellers can be easily withdrawn after installation. Outlets shall be flanged and inlets shall be flanged or spigoted as indicated, except that for suction pressures greater than 1000/Nm² (100mm of water) inlets shall be flanged. Dimensions and drillings shall be in accordance with BS 848:Part 4 (currently in preparation). In all cases the flexible and rigid joints shall be airtight

Casings and scrolls shall be formed from galvanised mild sheet steel, unless otherwise specified in **Part 3**, with lock formed joints. Spot welded stiffeners may be used on fans of up to 1 kPa static pressure.

Access panels incorporating air seals shall be provided in casings to facilitate cleaning and maintenance of impeller. A plugged drain shall be fitted at the lowest point of casing.

Impellers shall be of mild steel protected against corrosion (or aluminium or other materials where indicated on schedules) and be of riveted or welded construction, with spiders or hubs of robust design, and shall be capable of running continuously at 10% over normal speed.

Impellers of fans consuming more than 1 kW at the fan shall be keyed to shaft or fixed with tapered bush fittings. On multiple impeller fans each impeller shall be supported by individual bearings and connected by means of flexible couplings.

Shaft bearings of belt driven single inlet fans shall be truly aligned and rigidly mounted on a pedestal common to both bearings. Double inlet, double width fans shall have plummer block pedestal mounted bearings at each side of the fan. Ball and/or roller bearings may be used as appropriate.

2.6 FANS

Unless otherwise indicated, centrifugal fans shall be driven by electric motors through V-belt drives.

When a fan is specified to convey noxious or flammable gases, a suitable gas tight seal to the shaft, and spark minimising features in accordance with BS 848:Part 8 (currently in preparation) shall be provided. No leakage will be accepted from these fans under operation.

AXIAL FLOW FANS

Axial flow fans shall be either the single stage type or the multi-stage contra-rotating type with each impeller mounted on an independent motor. Casings shall be rigidly constructed of mild steel protected against corrosion or of aluminium alloy or other materials as specified in **Part 3** and stiffened and braced where necessary to minimise drumming and vibration.

Casings shall be fully air tight of the type indicated, with electrical connection to motor through flexible conduit fully wired to a suitable terminal box secured to the casing.

A removable inspection panel incorporating an air seal shall be fitted to casings of 450mm dia. or greater.

Inlet and outlet ducts shall terminate in flanged rings to BS 6339 or BS 848:Part 4 (currently in preparation) for easy removal. The length of the duct casing shall be greater than the length of the fan/s and motor/s in order that the complete section may be removed without disturbing adjacent ductwork.

Cast iron or fabricated steel feet shall be provided where necessary for bolting to the base or supports.

Impellers shall be manufactured from mild steel protected against corrosion, aluminium or moulded reinforce plastics as specified in **Part 3**, with aerofoil section blades capable of pitch adjustment or fixed, as specified on the schedules.

The blades shall be of true aerofoil section and secured to the hub, or alternatively, the blades and the hub shall be formed in one piece. The hub shall be keyed and fixed to a substantial mild steel shaft. Shafts shall be carried in two bearings which may be ball or roller type. Lubricators shall be extended to the outside of the casing.

Where axial flow fans are specified to be driven by a motor external to the fan casing, the requirements of the clause for pulleys and for V-belt drives and guards shall be met. Unless otherwise indicated, a guard is not required for any part of a drive which is inside the fan casing or unless the fan is open-ended. An access door of adequate size shall be provided.

Where axial flow fans of the bifurcated type are indicated, the motors shall be out of the airstream. Motors may be placed between the two halves of the casing in the external air or may be placed within the fan casing provided that effective ventilation is given to the motor. Where hot gases or vapours are being handled, the motor and the bearings shall be suitable for operation at the temperature they may experience.

The casing shall be of the same thickness throughout and shall extend for the overall length of the impeller, hub and motor protection tunnel and have circular flanged ends, constructed from mild steel with continuously welded joints, lined or finished to suit application. The impeller shaft shall have a seal at tunnel wall to prevent leakage in either direction. No leakage will be accepted.

MIXED FLOW FANS

In-line centrifugal and mixed flow fan casings shall be rigidly constructed of mild steel protected against corrosion, or aluminium alloy, as specified in **Part 3**, stiffened and braced where necessary to minimise drumming and vibration.

2.6 FANS

Casings shall be fully air tight of the type specified, with flanged inlets and outlets, stator vanes being of the same material as casing. A removable inspection panel incorporating an air seal shall be fitted to casings of 450mm dia. or greater.

Casings shall cover the overall length of the impeller, hub, motor, inlet cones and discharge straightening vanes.

Impellers shall be mild steel protected against corrosion or aluminium with blades welded or riveted to the impeller hub and shroud as specified in **Part 3**. Impellers with an outside 500mm dia. or less may be die-cast aluminium with a fitted shroud.

Electrical connections to fans with direct-drive motors or motors mounted inside casing shall be fully wired through flexible conduit to a suitable externally mounted terminal box.

Fans driven by externally mounted motors when specified in **Part 3** shall have twin bearing mounted steel impeller shafts. The drive shall be arranged to minimise air leakage and allow access to pulleys and belts. Belt driven units shall be provided with guards to belts and pulleys, a minimum of two belts shall be used on drives.

PROPELLER FANS

Propeller fans shall be ring or diaphragm mounted as specified. Impellers shall be manufactured from mild steel protected against corrosion, aluminium or plastic as specified. The blades shall be securely fixed to the hub or formed in one piece. Shafts shall be fitted with lipped slinger rings shaped to suit the fan mounting attitude. Vertical shaft fans, with the impeller mounted above the motor, shall be fitted with an impeller spinner.

ROOF MOUNTED UNITS

Roof mounted units and extract units shall meet the appropriate requirements relating to fans generally and to particular type of fan used in the preceding clauses.

Cowls and bases shall be of materials which are resistant to the weather, solar radiation, and are appropriate to the location and use specified. Bird and vermin screens shall be fitted.

Casings shall be complete with integral weather-proofing provisions suitable for direct fixing to the building structure in accordance to the Manufacture's instructions.

Adequate access to electrical supply terminals and lubrication points shall be provided by means of hinged cowls or other means as appropriate.

All accessories as specified or appropriate shall be provided.

PACKAGED DUPLICATE FAN UNITS

Packaged supply and extract fan unit housings shall contain all components of the unit except the terminal box for electrical connections. Dust protected access covers to IP51 or BS EN 60529 shall be provided for inspection and replacement of all components.

No electrical components shall be fixed to or supported by any access cover. An isolator/terminal shall be fixed to the outside of the casing in a suitable position and wired back to motors.

Unless otherwise indicated, the fans shall be arranged for automatic change-over.

Housings and cowls of externally mounted units shall be weatherproof and manufactured from galvanised mild steel, aluminium alloy sheets or glass reinforced plastic to BS 3532 as specified and assembled with compatible and non-corroding nuts, bolts, washers and ancillary items. Plantroom units may be supplied in chassis form where indicated.

2.6 FANS

Inlets and outlets shall be weather-proof and provided with bird and vermin screens. Belt driven units shall be provided with belt guards unless access/electrical interlocks are provided.

Each fan damper shall close when the fan is de-energised. Dual fans and motors shall be mounted on a common base plate supported on anti-vibration mountings. All items shall be treated against corrosion.

Backdraught dampers shall have edge seals and shall open and close fully. Multiple blades shall be mechanically linked being closed by gravity or light springs.

Fan failure in units consuming less than 500W at the fan shaft shall be sensed and indicated from switches operated by damper blade movement, unless otherwise indicated. Double throw air flow switches shall be used in units consuming more than 500W at fan shaft.

CORROSIVE/HAZARDOUS APPLICATIONS

Where fans are specified to handle toxic, corrosive, flammable, explosive or high temperature gases, the materials used in construction shall be suitable for application and all relevant safety regulations shall apply. No leakage will be accepted for fans used in these applications.

Bearings and lubrication arrangements, electrical equipment shall be suitable for the conditions.

Where fans are for use on potentially explosive atmospheres or gases, bifurcated fans should be used in all practical instances.

Protectively coated fans shall meet the appropriate requirements of the preceding clauses relating to fans generally and to particular types of fans. Form of protection shall be as indicated in **Part 3** and on the schedules. Where a protective coating is required for use with corrosive gases, the coating shall cover all parts of the complete fan, motor and casing assembly which will be in contact with the corrosive gases. No fan shall be installed if the protective coating has been damaged in any way. Flame-proof enclosures shall comply with the requirements of BS 229 for the appropriate gas group.

VARIABLE VOLUME & SPEED DEVICES

The following variable volume and speed devices shall be used as specified in **Part 3**:-

Variable Pitch Inlet Guide Vanes

Where specified in **Part 3**, centrifugal fans shall be fitted with variable pitch inlet guide vanes matched to the fan performance to give stable control, and be of the backward curved blade type.

Variable Pitch In Motion Axial Flow Fans

Where specified in **Part 3**, axial flow fans shall be fitted with variable pitch in motion impeller blades designed to give stable control over the duty range specified and having either electric or pneumatic actuator control as specified.

Inverter Drives

Where inverter drives are specified in **Part 3** of this specification, they shall be selected to give stable control over the whole operating range. They shall meet the requirements of European Legislation relating to electromagnetic compatibility. The Manufacturer shall provide facilities to block out any speeds at which the fan is in resonance with the forcing mechanism. The relationship between voltage and frequency shall be matched to the fan absorbed power requirements.

2.7 AIR FILTERS

GENERAL

Air filters shall be provided as defined within the schedules and **Part 3** of this specification for use in air handling plant or for independent mounting and be of the grades and types specified.

Filter assemblies shall operate with not less than the efficiencies or values of resistance specified for individual cells, with no material or wetting agents being carried over into the airstream.

Filter cell holding frames shall be purpose made from non-ferrous metal, steel protected against corrosion, of adequate strength, being stiffened as required to prevent distortion in use; securely fixed in position with all edges and joints effectively sealed to prevent air leakage, and shall be capable of retaining cells in a rigid manner without edge leakage. The seal shall remain effective even though the cells are periodically removed and refitted. Filters shall be arranged so that there is easy access for cleaning and/or removal and refitting. Any tools necessary for removal and refitting shall be provided including a servicing rack where applicable.

Unless otherwise indicated, filters shall be arranged for face withdrawal. Filter casings as required shall be provided with adequate access to allow removal and refitting of cells or replacement of gaskets in holding frames.

A differential pressure gauge of the dial or inclined manometer type shall be provided for each filter bank and shall be fixed in such a position outside the duct system that it is accessible and easily read. The design air velocity through clean filters (or operating resistance of automatic filters) shall not be exceeded to ensure that filter fabric is not carried over into the system.

A volt free switch will be incorporated into the differential pressure gauge arrangement. Where specified in **Part 3**.

Filter grades shall be Eurovent standards defined by grade being tested to BSEN 779:1993 and BS 3928 as appropriate. Performance certification issued by an accredited test laboratory shall be provided for each type, with HEPA filters to BS 3928 being provided with individually test certificates as required. Where specified in **Part 3**, the HEPA filters shall also be tested to BS 5295.

Sufficient spare cells shall be supplied initially to provide new and clean filters at time of handover and also one spare set for each filter position for entire installation for handover to Client or his Representative, being carefully packed for storage and labelled for respective plant and filter types.

Filter media construction materials, adhesives, coatings and wetting agents shall permanently retain self-extinguishing properties. When exposed to heat or flame, they shall not generate significant quantities of smoke or toxic fumes. In no case shall the total toxic vapour emission into air stream, calculated over a period of 10 minutes, result in the exposure level of any toxic constituent exceeding levels as given in the current Health & Safety Executive Guidance No. EH40. Filters shall be free of asbestos, metal wool, plastic foam type materials, or any materials which may introduce hazards from smoke or toxic fumes if involved in a fire.

Where flameproof filters are indicated or specified, they shall comply with the performance requirements of BS 476:Part 12 with casing and frames being classified as non-combustible when tested in accordance with BS 476:Part 7.

Surfaces of air filters exposed to airflow should be inherently non-flammable or so treated that they retain these qualities throughout their working life in accordance with BS 5588:Part 9.

Where filter medium is required to be flameproof and the filter is built into sheet metal ducting, the ducting shall be not less than 1.6mm thick for at least 1.8m upstream and 1.8m downstream of the filter elements and be of material complying with BS 476:Part 4.

PANEL FILTERS

Flat panel filters shall be provided to the specified grade or better, being disposable or replaceable as specified, with maximum air velocity at face not exceeding 2.0 m/s. High performance pleated/extended surface panel

2.7 AIR FILTERS

filters may be employed on face velocities up to 3.0 m/s. Panel filters may be arranged in V-bank formation to ensure compliance with face velocity requirements.

Cardboard filter casings shall be treated for use in conditions up to 80% saturation and shall be adequately stiffened to prevent distortion in handling

BAG FILTERS

Bag or extended surface type filters shall be provided to the required grade or better as specified, with maximum air velocity at face not exceeding 3.0 m/s.

Filters shall be fully self-supporting without external ties or stiffening frames. Filters shall inflate fully, shall not sag or flutter, nor have effective medium area reduced by obstruction due to contact with other filter faces or housing surfaces when operating between 60% and 110% of design air volume for constant volume systems or between the specified minimum and maximum air volume rates for VAV systems.

Panel filters shall be provided before bag filters as a pre-filter unless otherwise specified.

HIGH EFFICIENCY FILTERS

High efficiency particle air filters shall be provided as specified in **Part 3** and in the schedules.

HEPA and ULPA filters shall be constructed from pleated glass paper or other approved media sealed within a rigidly constructed case.

Unless otherwise indicated, a 6mm minimum thickness gasket shall be fitted to the downstream face of the filter cell. The gasket shall be of one piece moulded construction or with all joints sealed to ensure a positive air seal through filter life.

The housing for the filter shall be manufactured from mild steel protected against corrosion, aluminium alloy or stainless steel as specified in the schedules, and provided with sealing gaskets and access covers retained by over centre cam operation or holding down bolts.

The filter housing, medium, protective cappings and sealing gaskets shall be of materials compatible with the temperature, humidity or corrosive conditions indicated in schedules in **Part 3** of this specification.

AUTOMATIC VISCOUS IMPINGEMENT FILTERS

Where specified, automatic viscous impingement filters shall be provided as specified in **Part 3** and in the schedules.

Filter frames shall be constructed from welded mild steel to form a rigidly supported self-contained unit with filter media being of fluid coated corrugated metal plates. Base of unit shall form the fluid reservoir tank complete with drain valve.

Cleaning and fluid re-coating unit shall be provided complete with pump and discharge mechanism. Unit shall be designed to ensure that there is no cleaning fluid carry over into airstream.

All electrical control equipment shall be provided in self-contained remote control box with timer and fused isolator.

Automatic desludging equipment shall be provided.

ACTIVE CARBON & ABSORPTION FILTERS

Where specified in **Part 3** and the schedules, absorption filters shall comprise panels, or impregnated media or beds containing absorbent medium evenly dispersed and assembled into a casing, panels being sealed effectively against air leakage.

2.7 AIR FILTERS

Casings and panel supports shall be constructed from metal adequately protected against corrosion and designed to provide mechanical protection to panels. Filter frames and absorbent medium retaining mesh shall be of non-combustible materials.

Filters shall be of uniform thickness, packed to ensure that compaction or voids do not occur in use. Bonding agents may be used provided that efficiency, absorption capacity and air flow resistance are maintained.

The resistance to air flow shall not exceed 125 Pa at the design flow rate. Filter shall be preceded by a dry fabric filter to EU7 Grade.

Each filter assembly shall include two detachable test sections for use in predicting the service life of the assembly. These test sections shall be exposed to full air flow, with replacement sections provided to enable analysis and prediction of service life to be made.

The absorbent shall be provided to such a quality and bed depth as to achieve the permitted concentration levels in the air stream leaving the filter bed.

Evidence as to both efficiency and absorption capacity shall be provided to the Engineers for acceptance.

Dwelling time shall not be less than 0.1 second. Weight of carbon per 1.0m³/s of air volume flow rate shall be as specified in **Part 3** and the Schedules.

ELECTRO-STATIC PRECIPITATORS

Where specified in **Part 3** and the schedules, electro-static agglomerator with bag type collector sections shall be provided. Casing shall be fabricated from mild steel sheet with epoxy resin finish, with flame-proof materials being used throughout assembly.

Units shall be supplied fully cased or as part of an air handling unit comprising perforated baffle or grid, ionizer section, collector section, wash plant including hot water storage, pump, distribution pipework, spray nozzles and drain system.

Electrical control panel with all required controls shall be provided together with interlocks on control panel and plant access door. An interlock shall be provided to prevent wash down whilst precipitator is energised.

Control panel and plant access door shall be provided with high voltage indication signs.

GREASE ELIMINATORS

Grease eliminators where specified in **Part 3** and in the schedules shall be of the corrugated plate, crimped wire mesh or baffle types manufacture in metal and be readily accessible and removable for cleaning.

Where specified for installation in kitchen hoods, the assembly shall include a drip tray with element secured in frame by quick release clips.

2.8 AIR HUMIDIFIERS

GENERAL REQUIREMENTS

Humidifiers shall be to the types, duties, manufacture and installation specified in **Part 3**.

They may be:-

- Direct steam injection type.
 - Electrode boiler, self-generative steam type.
- or to a further type specified in **Part 3**.

All ductwork and casings enclosing humidifying plant shall be air and watertight. Ductwork, plant and components shall be protected from corrosion either by choice of materials or by an approved protective finish. Particular care shall be taken in the design of plant and the choice of materials to minimise electro-chemical reaction between dissimilar metals.

Units shall be complete with all necessary devices for fixing to ductwork sides, air handling unit casing or supporting from adjacent walls or from the floor as indicated.

Units shall be constructed from materials which will withstand bio-degradation; this applies particularly to mastics, gaskets, insulation etc.

Injection pipes for injection of dry steam shall be stainless steel to BS 1449:Part 2:Grade 316 as advised.

Arrangements shall ensure that only dry steam is delivered into the airstream.

Means of electrical isolation of self-generative steam humidifiers shall be arranged to facilitate removal of the elements/electrodes for maintenance and replacement.

Self-generative steam humidifiers shall be connected to an indirect water source and shall comply with Local Authority Bye-Laws and The Water Acts.

The units shall be arranged to completely mix steam with air without carry-over of moisture and must have at least 1 metre without obstructions downstream. An eliminator to be provided if required.

Units to be provided with an easily removable drip tray designed to a fall of 1 in 20 in all directions to the drain outlet and self drain under working conditions to avoid formation of pools of water. The drain outlet must be suitable for connection to a trap and a drainage system.

When installed in ductwork the units are to be supported independently so that ductwork does not take the weight and arranged for easy removal of manifold and associated pipework without disturbing ductwork or other services.

Direct injection systems shall be tested at the Manufacturer's works for pressure soundness 1.5 x working pressure minimum and certificates provided.

Units shall be provided with outer casing constructed to withstand maximum static pressure of the system without air leakage.

Duct or air handling plant shall be provided with an airtight access door, complete with viewing window, designed to afford easy access for inspection and cleaning. The door to be fitted with a large PVC label (RED lettering on WHITE background) stating:-

“WARNING”

**INTERMITTENT LIVE STEAM FROM MANIFOLD WITHIN
DO NOT ATTEMPT TO SERVICE WITHOUT CLOSING STEAM SUPPLY**

2.8 AIR HUMIDIFIERS

Units shall be provided with a waterproof extra low voltage swimming pool type luminaire switched from outside adjacent to the access door and provided with electrical terminal box on outside of casing pre-wired to the lights and switch.

Units to be manufactured from materials that are suitable to withstand external cleaning with a water solution containing 5ppm chlorine.

DIRECT STEAM INJECTION TYPE

The units shall comprise separation chamber, modulating valve, drying chamber and distribution manifold complete with steam jacket. The unit shall be complete with:-

- Steam stop valve and strainer fitted to the steam inlet connection.
- Scale pocket, float trap complete with automatic air vent, and isolating valve connected to separation chamber.
- Steam distribution pipe, designed and installed to incorporate condensate return and ensure free moisture is not carried over into the airstream.

ELECTRODE BOILER, SELF-GENERATIVE TYPE

Electrode boiler steam humidifiers shall have separate steam and control compartments formed in one enamelled steel casing with lockable doors. Steam generating cylinders shall have a steam outlet hose connecting to the duct steam injection pipe.

Where located within the airstream, steam generating cylinders shall be constructed of non-flammable materials. Units shall “fail-safe” in the event of interruption of power or water supplies. A spare cylinder shall be provided with each unit.

Automatic emptying of steam generating cylinders shall be pump assisted.

Units shall be pre-wired internally with the terminals for incoming power and control circuit connections. A full height access opening shall incorporate indicator lamps and switches. Control methods that employ draining or refilling of the steam generating cylinder to achieve variations in steam output will not be permitted.

2.9 HEAT RECOVERY DEVICES

GENERAL

Heat recovery devices where specified in **Part 3** shall provide the recovery duties specified, or better, to give the highest practical efficiency under operating condition, being arranged for plant or duct mounting as specified in the schedules and **Part 3**.

THERMAL WHEELS (AIR HEAT RECOVERY)

Thermal wheels of the rotating regenerative air-to-air type shall transfer sensible and/or total heat as specified in **Part 3** between the exhaust and take airstreams.

Thermal wheels shall consist of a rigid mild steel casing protected against corrosion, to a similar standard to that specified in air handling plants section, containing a sectorised wheel composed of aluminium foil or other approved exchange media, treated with a coating having the necessary hygroscopic properties, where total heat extraction is specified. This coating of the media shall not support bacteria, fungi or mould growth.

A central division plate shall separate the intake and exhaust airstreams being provided with an adjustable and replaceable sealing strip to minimise cross-leakage between airstreams. A purging section shall be provided giving a maximum certified carry-over of 0.05% of the intake air volume with directionally orientated media.

The motor shall be complete with mounting bracket, gearbox, drive system, drive guards and controls suitable for single speed or variable speed operation as specified in **Part 3**. Provision shall be made for adjustment of drive belts or chain tension.

Drilled flanges shall be provided for fixing in to air handling plant or ductwork systems as specified.

Access doors shall be provided on each side of recovery unit in both intake and exhaust airways of sufficient size as to allow maintenance of unit.

PLATE HEAT EXCHANGERS (AIR HEAT RECOVERY)

Recuperative plate heat exchangers shall be constructed to the same standard as the air handling plant in which they are fitted or to a similar standard for duct mounted units to provide the duties as specified. Drilled end flanges being provided to match air handling unit or for duct connection as set out in the schedules.

Each unit shall comprise heat transfer plates of commercially pure aluminium or other approved material, arranged for cross-flow of airstreams, with synthetic rubber sealing joints to ensure that no mixing can occur between airstreams.

A trapped condensate drain shall be provided and provision shall be made for cleaning of heat exchange surfaces. The entire unit being suitable for operation in the conditions specified.

RUN AROUND COILS (AIR HEAT RECOVERY)

Run around coils, where specified in **Part 3**, shall be constructed and arranged in accordance with coils and batteries section of this specification using the materials as specified, to achieve the duties as specified under schedules of equipment and be suitable for mounting in AHUs or ductwork as applicable.

Coils shall be suitable for use with the transfer medium and under the specified operating conditions.

Run around coils shall be provided complete with interconnecting pipework, circulation pump, stand-by pump, starter/isolator, break tank or expansion vessel as specified in schedules and shown on the drawings. Run around coils and system shall be filled with a glycol solution where freezing may occur to the concentration specified in **Part 3** or in the schedules.

2.10 GRILLES, DIFFUSERS, TERMINAL DEVICES & LOUVRES

GENERAL

All terminal devices shall be of fully welded construction and selected to meet the design criteria specified in Part 3 and in the schedules in respect of noise and comfort. All terminal devices shall be finished in epoxy or polyester powder coat (unless specified otherwise in Part 3) in the colour to be specified in the schedules. BS or RAL colours shall be standard. All dampers, blades and operating mechanisms, visible inside the diffuser and/or plenum box, where applicable, shall be finished in matt black.

Where plenum boxes are called for in the schedules, the lining shall be non-fibrous, Class "O" fire rated insulation to Local Authority approval.

The Installer shall make himself familiar with the application of the device, its location and the configuration of the space in which it is to be located.

All terminal devices shall be secured to the ductwork walls or ceilings by concealed quick release fixings. Liaison with the ceiling specialist shall take place to ensure the ceiling installation can adequately support the terminal devices.

A neoprene, or equivalent, sealing strip shall be provided on each terminal device to provide an airtight seal. This shall be to Local Authority approval.

All terminal devices shall be designed/installed for easy removal for cleaning and arranged for insitu adjustment from within the room and shall be complete with sealing gaskets and free from burrs with all ledges or crevices designed so that dust build up can be kept to a minimum.

To be tested at the Manufacturer's works or an approved testing laboratory for flow and noise to BS 4773:Parts 1 and 2 and certificates provided.

Units shall be of aluminium construction unless specified in Part 3 or in the schedules.

LINEAR SLOT DIFFUSERS

Linear slot diffusers shall be fitted with equalising grids either on the back of the diffuser or in the associated plenum to ensure even air distribution and plenum boxes shall be selected for the air volumes, throws and noise levels specified in the schedules.

The inlet connections to the plenum boxes shall be fitted with butterfly dampers, the inlet velocity shall not exceed 3.8m/s, unless otherwise specified in Part 3 or schedules. The dampers mechanism shall be operable through the diffuser blades.

Linear slot diffusers shall be manufactured from extruded aluminium of fully welded construction with mitred end caps and concealed fixings and shall be sufficiently rigid to maintain the size and form of the connecting duct or plenum.

The assembly of the slot diffuser and plenum shall be of such a form as to make regular cleaning of the system possible.

DOUBLE DEFLECTION GRILLES

Double deflection grilles shall be manufactured from extruded aluminium of all welded construction and be provided with opposed blade volume control dampers, operable through the face of the grille.

2.10 GRILLES, DIFFUSERS, TERMINAL DEVICES & LOUVRES

PRESSURE RELIEF GRILLES

These shall be of the balanced blade type for pressure relief flaps, with fine adjustment of relief pressure settings and with a seal as airtight as practicable when closed.

PLENUM BOXES

Plenum boxes, when required, shall be as specified in the schedules and **Part 3** of the specification.

EXTRACT GRILLES

These shall be of manufacture from extruded aluminium and be fully welded construction.

Grilles shall be fitted with one set of blades fixed or adjustable as defined on the schedules provided with opposed blade volume control dampers, operable through the face of the grille.

EGG CRATE GRILLES

Egg crate grilles shall be manufactured from extruded aluminium border and fabricated aluminium core and be provided with aluminium opposed blade volume control dampers, operable through the face of the grille.

LOUVRE FACE DIFFUSERS

Louvre face diffusers shall be manufactured from extruded aluminium and of fully welded construction and be suitable for providing air distribution in 1, 2, 3 or 4 directions (dependent on core pattern) as defined in **Part 3** and the schedules.

The core shall be easily removable for fixing and cleaning.

Diffusers shall be provided with opposed blade volume control dampers, operable through the face of the diffuser.

PERFORATED FACE DIFFUSERS

Perforated face ceiling diffusers shall be manufactured with an extruded aluminium border with mitred welded corners and perforated plate and aluminium or steel neck and spigot. The diffuser shall incorporate a quick release perforated plate which can be pivoted down to allow access for installation and cleaning and regulation of the opposed blade damper which shall also be incorporated.

TRANSFER GRILLES

These shall be of the non-vision type.

WEATHER LOUVRES

Weather louvres (acoustic/non-acoustic) shall be specified in **Part 3**. The Contractor shall be responsible for ensuring correct hole sizes, fixing details and weathering requirements are provided for the louvres under other aspects of the works.

Corrosion resistant weather-proof louvres and mesh screens shall be fitted at all external intake or exhaust positions. Mesh to be not less than 6mm and not more than 12mm.

The louvres shall be suitable for the conditions in which they are located.

2.11 REFRIGERATION PLANT

GENERAL

The refrigeration plant/s shall be as specified in **Part 3**.

Where the refrigeration plant/s are specified for mounting externally the units shall be constructed of materials which are either proven to be corrosion resistant or made proof against corrosion at works.

The equipment shall be provided to form a fully factory engineered and assembled operational package with all mechanical and electrical equipment matched to operate as a complete system. The complete installation shall perform in accordance with the information set out in the schedules in **Part 3**.

The plant shall be of mechanical vapour - compression type using refrigerants that are low ozone depletion and low global warming potential.

The use of refrigerant R22 is not permitted. The use of refrigerant R407C with zero ozone depletion potential and low global warming potential shall be as specified in **Part 3**.

The machines shall be capable of running continuously at the lowest step of cooling capacity without any adverse affect.

The method of operation and control of the plant within the system shall be as described in the controls section of this specification and as indicated on the schematic diagrams.

Installations shall comply with BS 4434 and "Safety Code for Refrigeration Systems Using Chlorofluorocarbons - Part 1".

After assembly of each machine is complete a strength pressure and leakage pressure test shall be followed, by a full factory operating test, under load conditions, for final calibration of all operating and safety controls and verification of unit performance. Water tests shall be to 1.5 times working pressure indicated in the schedules. Tests on refrigerant side to be to BS 4434.

The machine shall be fully thermally insulated and shall comply with the Local Authority requirements.

The machines shall be in accordance with the acoustic criteria stated in the schedules.

All electrical equipment provided with or installed within the machine shall be in accordance with BS 7671.

To minimise the possibility of refrigerant emissions to atmosphere, refrigerant pipework joints shall be kept to a minimum. Wherever possible, brazing or welding is preferable to flared, screwed or flanged connections.

The refrigeration system shall be protected by a pressure relief device unless it is so constructed that pressure due to fire conditions would be safely relieved. The means of discharge and equipment provided shall comply with BS 4434 and the outlet shall be piped to a discharge outside the building in a safe location.

Each refrigeration system shall be complete with suitable connections for the safe removal of the complete refrigerant charge.

The machines shall be provided with anti-vibration mounts.

The machines shall have all necessary control and safety devices, flow switches, differential pressure switches, sequence controllers necessary for their operation within the system.

2.11 REFRIGERATION PLANT

The various components shall be suitable for starting and operating within the stated range of internal and external ambient conditions as specified in **Part 3**.

COMPRESSORS

(As defined in **Part 3** of this specification or in the schedules.)

Centrifugal Compressors

The centrifugal compressors shall have hermetic drive design.

The compressor shall have automatic capacity regulation which will control at any point from 10% to 100% of full duty without inducing surge condition or excessive vibration. The compressor shall not be enabled to start unless in the fully unloaded condition. Capacity variation shall be by means of inlet guide vanes.

The lubrication system shall be arranged with an interlock to ensure adequate oil pressure at all bearings before the compressor starts and during the "coast down" period including conditions due to power failure. A replacement or cleanable filter shall be positioned in the oil delivery pipe. A hand reset safety device shall stop the compressor on a lubrication systems failure. Where an oil cooler is used it shall be thermostatically controlled. The oil sump shall have a thermostatically controlled electric heater which shall operate while the compressor is at rest.

The compressor assembly shall be statically and dynamically balanced at works and provision shall be made to reduce to a minimum loads on thrust bearings.

The following shall be provided, together with any other safety devices necessary, for the safe operation of the machine:-

- Refrigerant pressure gauges.
- Oil pressure gauge.
- Oil sump or reservoir level sight glass.
- Pressure operated safety cut-outs.
- Low pressure cut-out or flow switch, both with hand reset facilities incorporated.
- High oil temperature cut-out with hand reset.
- High bearing temperature cut-out with hand reset.
- High motor temperature cut-out with hand reset.

Reciprocating Machines

The compressors shall be hermetic or semi-hermetic with serviceable type replaceable cylinder liners as specified in **Part 3**.

Capacity control shall be by cylinder unloading or speed change and shall be arranged so that starting is in the unloaded condition. Each machine shall have twin refrigeration circuits, unless otherwise specified in **Part 3** or in the schedules.

Provision for draining oil from the suction manifold into the crankcase shall be provided and for the venting refrigerant gas (not oil) in the opposite direction.

A crankcase heater shall be provided and arranged to operate while the compressor is at rest with protection device to prevent starting before oil has reached the minimum operating temperature.

Service stop valves shall be provided on compressor suction and discharge connections.

2.11 REFRIGERATION PLANT

The following shall be provided together with any other safety devices necessary for the safe operation of the machine:-

- Service stop valves on compressor suction and discharge connections.
- Refrigerant pressure gauges.
- Oil pressure gauges.
- Crankcase oil level sight glass.
- Low oil differential pressure safety cut-out with hand reset (with compressors operating at an excess 100kPa differential pressure).
- Refrigerant suction gas strainer.
- Internal pressure relief valve (compressors in excess of 35kW power input).
- Vibration isolation incorporated in refrigerant lines of compressor.

Screw Compressors

The compressor/s shall have automatic capacity control equipment which shall enable it to control at any point between 10% and 100% of full duty.

They shall not be able to start unless in the fully unloaded condition.

The lubrication system shall be arranged to give adequate pressure at all bearings as the compressor starts.

A hand reset pressure or flow switch shall stop the compressor on lubrication failure. The pipeline from a positive oil displacement unit or pump shall incorporate a pressure regulating valve to receive excess oil at the reservoir. A replacement or cleanable filter shall be positioned in the oil delivery pipe. A thermostatically controlled oil cooling system shall be used to remove heat gained by the oil. The oil sump shall have a thermostatically controlled electric heater.

The following shall be provided together with any safety devices necessary for the safe operation of the machine:-

- Service stop valves on compressor suction and discharge connections.
- Refrigerant pressure gauges.
- Oil pressure gauge.
- Oil reservoir level sight glass.
- Low oil pressure cut-out or flow switch with hand reset facilities.
- High oil temperature cut-out with hand reset.
- Refrigerant suction gas strainer.

Compressor units shall be suitable for continuous and automatic operation and free from vibration.

EVAPORATORS

Shell & Tube Evaporators

Evaporators shall be of the shell and tube type, capable of being re-tubed insitu. The design fouling factor on the water side of the tubes shall be as indicated in the schedules. The evaporator shell and tube plates and end covers shall be welded carbon steel plate construction to the relevant BS, ASME or DIN standards, or cast iron.

The complete water side of the evaporator shall be hydrostatically tested to the test pressures specified in **Part 3** and on the schedules prior to despatch from works.

The shells shall be complete with water boxes having end inlet/outlet pipework connections flanged to BS 4504 or grooved ends for mechanical joints as indicated in the schedules.

2.11 REFRIGERATION PLANT

Removable bolt-on cover plates so arranged to provide access to the tubes without breaking the water connections shall be installed. Air vent and drain cocks shall be provided on the water boxes.

Tubes shall be of a seamless copper construction and shall fit into tube support plates in such a way as to prevent vibration between tubes and support plates, but not so tightly that the tube withdrawal and replacement is impaired.

The design of the heat exchangers shall be such that carry over of liquid refrigerant from the evaporator is prevented at all loads and that the liquid in the evaporator and condenser is maintained at the necessary level to optimise operating economy.

A low temperature thermostat with hand reset shall be provided for each shell and tube evaporator to stop the compressors if the chilled water flow temperature falls below +3°C unless otherwise specified in **Part 3** and the Schedules.

The evaporators shall be insulated at works to meet the Local Regulations and fitted with a heater mat for frost protection.

Direct Expansion Evaporators

The evaporator shall be of the direct expansion type in the form of a cooling coil in the air handling plant described in **Part 3** of this specification.

The design of the package refrigeration plant and its controls shall be compatible with the direct expansion coil and its controls and shall comply with the requirements of the control section of this specification, in particular that relating to the control of the particular air handling unit which it serves.

Plate Heat Exchange Evaporators

Plate heat exchangers shall be of the stainless steel brazed plate type. If two or more evaporators are included, the unit shall have interconnecting water pipework to provide a single inlet and outlet to the system water connections.

CONDENSERS

Air Cooled Condensers

The air cooled condensers shall be of refrigerant quality seamless copper tubes with aluminium, copper or electro-tinned copper fins as specified in **Part 3**. Completed coils shall be pressure tested at works. Provision shall be made for the purging of non-condensables from the condenser.

The condenser fans shall be controlled to maintain the head pressure within the operating bands of the equipment.

The externally mounted air cooled condenser fans shall have weather-proof motors. Fan outlets shall be suitably protected. The condensers shall be package mounted or suitable for remote installation as specified in the schedules.

The fan compressor and overall noise levels shall be in accordance with the schedules and the acoustic section of this specification and comply with the Local Authority requirements.

2.11 REFRIGERATION PLANT

Water Cooled Condensers (Shell & Tube)

Shell and tube condensers shall be of the manually cleanable type capable of being re-tubed insitu. The condenser shell tube plates and water boxes/end covers shall be welded carbon steel plate construction to the relevant BS, ASME or DIN standards, or cast iron. The complete water side of the condenser shall be hydrostatically tested to the specified test pressures prior to despatch from works.

Water connections shall be flanged to BS 4504 or have grooved ends for mechanical joints as indicated in the schedules.

Tubes shall be of a seamless copper construction and shall fit into tube support plates in such a way as to prevent vibration between tubes and support plates, but not so tightly that the tube withdrawal and replacement is impaired.

End covers shall be removable and allow easy access for cleaning the tubes. A means shall be provided for venting and draining of the water side of the unit by the Refrigeration Plant Manufacturer.

The head pressure control shall be from the heat rejection equipment as specified later in this specification.

A means shall be provided for the controlled venting of non-condensables from the refrigerant side of the condenser.

REFRIGERATION PLANT ACCESSORIES & CONTROLS

Refrigerant Circuit Components

The refrigerant circuits shall include for the following components as a minimum:-

- Liquid line shut off valves.
- Charging valve.
- Filter drier.
- Solenoid valve.
- Site glass and moisture indicator.
- External relief valve and expansion device.

Control Panels

Each machine shall be complete with control panel fixed to the machine and completely factory assembled and wired including all necessary operating limit and safety controls mounted in a steel enclosure.

An integral step down transformer where required shall be installed within the control panel and factory pre-wired to serve the machine control circuits.

Control panels shall be fully equipped, wired and tested before delivery to site. A functional test simulating operation of the complete panel shall be performed before despatch.

After electrical power is disconnected from the machine, the control system shall allow the machine to be manually re-started and running up to full capacity within a short period of reinstatement of electrical power. Protection shall be provided to ensure that the machine is not damaged should mains power be restored before the machine is at rest.

The control panels shall contain all the necessary operating and safety controls, ancillary equipment and safety devices necessary for the safe and automatic operation of the machine/s.

2.11 REFRIGERATION PLANT

Each control panel shall include the following together with any other items required to its safe operation:-

- Single power input connection complete with 3-phase fuses.
- Overload protection and control circuit fuses.
- Compressor motor winding high temperature protection - manual reset.
- Compressor anti-recycle timers.
- Condenser and/or evaporator water flow switch.
- Low oil pressure protection.
- High oil temperature thermostat - manual reset.
- High and low refrigeration pressure safety cut-outs with adjustable differential and set point - manual reset.
- High and low differential pressure switch sensing across the inlet and outlet water connections of the condenser and/or evaporator.
- Freeze protection.
- Refrigerant suction and discharge pressure indicators.
- Door interlocked mains isolator.
- Oil pressure and temperature gauges.
- Terminal board for external interlocks.
- Volt-free contacts for remote monitoring by BMS for status and alarm indication.
- Operation thermostats.
- Enable/disable contacts for remote start/stop.
- All safety controls and devices are to be hard wired into the control circuit - **not via the BMS.**

Wiring shall be in accordance with BS 7671.

The control panel or similar shall be in accordance with BS EN 60439, BS 5486:Part 11 and Part 12, BS EN 60529 and BS EN 60947-1. The isolating switch or switch fuse shall be interlocked with the main door. The switch or switch fuse shall be in accordance with BS EN 60947-3 with BS 88 fuses. The safety of the whole shall be as BS 2771:Part 1:1986.

Control voltages shall be as standard British voltage, ie. 240 Volts or 110 Volts with tapped to earth transformer to BS 3535.

Indicators to BS EN 60073.

Miniature fuses to BS EN 60127.

Control switches to BS EN 60947-5-1.

Control panel internal power wiring shall be individually identified.

Control circuit and other wiring shall be to BS 6231 with identifying code extending to each cable termination using ferrules or other approved permanent means of attachment. Secure fixing of all cable ends shall be ensured by the use of purpose-made clamps, pinch-type terminals, crimped cable tags or other approved termination devices.

Fuses, terminal blocks and all other items of equipment within panels shall be suitably identified by means of clearly inscribed labels of a permanent nature attached or adjacent to them. All items on the outer surfaces of panels shall be identified with laminated plastics engraved in black on white. The full requirements of Clause 5 of BS EN 60439-Part 1 shall be provided. Protection shall also be provided for any live terminals to ensure compliance with regulations.

Unless otherwise indicated, contactor and/or starters shall comply with BS EN 60947. The “rated duty” shall be “intermittent” and the class of intermittent duty of the starter shall be appropriate to its operating conditions.

2.11 REFRIGERATION PLANT

The following types of starters shall be provided unless otherwise indicated in the schedules or set out in **Part 3**:-

- Motors up to 0.75kW output, 240V, single phase; direct on-line.
- Single speed motors up to 7.5kW output, 415V, 3-phase; direct on-line, star delta or soft start.
- Single speed motors over 7.5kW output, 415V, 3-phase; star delta open or closed transition, auto-transformer closed transition, rotor resistance, part-winding or soft start.
- For multi-circuit winding motors (part-winding), the starter shall start the motor on one set of windings and provide a reduced starting current not exceeding 65% of full voltage locked rotor current.
- Multi-speed motors with independent windings shall start on the low speed windings.

Where thermistor protection is provided, a minimum of 3 No. thermistors shall be incorporated within the motor windings.

Each control panel shall include the following indication (as a minimum):-

- **Common Indication**

Power "on".
Unit tripped - high pressure.
Unit tripped - low pressure.

- **Individual Indication per Compressor**

Compressor tripped - low oil level.
Compressor tripped - motor overload.
Compressor tripped - high oil temperature.
Compressor tripped - motor high temperature.
Compressor anti-recycle timer running.

The acoustic requirements for the machines shall be as defined in the schedules.

DRY AIR COOLERS

The air cooled coolers shall be of seamless copper tubes with aluminium, copper or electro-tinned copper fins or as specified in **Part 3**. Completed coils shall be pressure tested at works. Provision shall be made for the purging of non-condensables from the condenser.

The cooler fans shall maintain the leaving water temperature within the operating bands of the equipment as specified.

The externally mounted fans shall have weather-proof motors.

Fan outlets shall be suitably protected.

The coolers shall be suitable for remote installation as specified in the schedules.

The fan noise levels shall be in accordance with the information schedules and specified in the acoustic section of this specification.

2.12 PACKAGE AIR CONDITIONING UNITARY & FREE-STANDING

Split Units

The split units shall be as specified in **Part 3** and shall provide the cooling/heating capacity and environmental control as set out in the schedules within the stated internal and external ambient conditions.

Each split unit shall be inclusive of all necessary components and controls to operate independently or in conjunction with multiple installations as shown on the drawings and defined in **Part 3**.

Each split unit shall comprise of room side fan evaporator unit and external condensing unit complete with interconnecting refrigerant pipework.

The cabinets shall be provided with rigid frame and flush fitting removable panels to provide access to all parts of the unit for installation and servicing. Panels shall be lined with fire-resistant non-eroding insulation material which has both thermal and acoustic properties and be to Local Authority approval.

The electrical power/control panel shall be situated within the unit behind a hinged access panel with interlocked isolator.

Evaporator coils shall be multi-row copper tube aluminium fin construction, providing a large surface area with stainless steel drain trays incorporating factory fitted condensate traps.

Evaporator fans shall be low speed DIDW fans with forward/backward curved impellers, sealed for life bearings and TEFC motors belt/direct driven.

Electric heaters, where specified in **Part 3**, shall be electric Incoloy sheathed elements with stainless steel fins balanced over 3 No. phases. They are to operate at black heat. The control shall be minimum two stages each protected by high temperature cut-out safety device.

Water heating coils, where specified in **Part 3**, shall be LPHW and be complete with 3-way modulating valve, water pressure and temperature test points.

Air cooled condensing units shall be matched to the specific AC unit duty and be a self-contained weather-proof unit constructed as a rigid framework galvanised steel base and channel feet complete with fully hermetic compressor condenser coil and cooling fan.

Compressor shall be fully hermetic type fitted with service stop valves, oil level sight glass, crankcase heater, high and low pressure safety cut-outs, internal re-setting overload device and pressure relief valve and all safety controls. They shall be provided with anti-vibration mountings and a flexible vibration eliminator shall be installed between the compressor and condenser coil.

The condenser coil shall be of multi-row copper tube aluminium fin construction sized against the full cooling duty of the evaporator section plus the compressor heat. Condenser liquid and compressor suction pipes shall terminate in stub connections through a recessed galvanised service panel. Suction pipework shall be looped to prevent vibration damage.

The condenser fan shall be direct driven axial type mounted on a galvanised diaphragm plate or other form as specified in **Part 3**.

Filters shall be fitted to intake/discharge side of the unit having an efficiency rating of 90% to Eurovent 4/5 or as defined in **Part 3**.

Controls shall be incorporated into the AC units located in an easily accessible position behind a hinged front access panel with interlocking power isolator.

2.12 PACKAGE AIR CONDITIONING UNITARY & FREE-STANDING

The controls shall be fully self-contained to provide independent operation of the split room AC unit but with the facilities to interconnect with other units in a multi-unit installation or provide BEMS interface and remote alarm functions through volt free contacts.

Self-Contained Units

The self-contained units shall also be as specified in **Part 3** and provide the environmental comfort control specified in the equipment schedules within the specified internal and external ambient conditions.

Each unit shall be inclusive of all necessary components and controls to operate independently or in conjunction with multiple installations as shown on the drawings and defined in **Part 3**.

Self-contained units shall be of the style suitable for window/through wall/in wall mounting, as specified in **Part 3**.

Each unit shall incorporate room side fan coil section and compressor with condenser coil and fan arranged to reject heat from evaporator and compressor to atmosphere.

The room side section shall be factory finished to provide an aesthetic appearance with integral insulation and discharge grille as defined in **Part 3**.

The external side section shall be factory finished to provide a weather-proof casing and grille.

Each unit shall incorporate a fresh air inlet and room air discharge connection and incorporate a room side filter.

The heating section shall be electric or LPHW as specified in **Part 3**.

The electric heater section, where specified, shall include block heat element mounting plate and additional controls.

The LPHW heating coil, where specified, shall be copper tube aluminium fin construction complete with mounting plate and shall be complete with necessary 3-way modulating control valves and controls and necessary balancing and isolating valves, water pressure and temperature test points.

AIR COOLING

Daikin DX equipment is to be used when ever possible.

Condensate drains shall be run to appropriate drains & gullies. Trapped outlets using an HepVo waterless trap shall be used.

All refrigeration lines and control cables are to be mounted on galvanised cable trays throughout the entire length.

Units are to be 24/7 time clock controlled using Daikin time clock controls. These units are to be mounted within clear Perspex lockable enclosures, unless specified otherwise.

Evaporators and condensers units are to be labelled with traffolyte self adhesive labels in accordance with the CA requirements.

COMPUTER FLOOR STANDING AC UNITS

Computer AC units shall be as specified in **Part 3** to provide the cooling capacity and environmental control as specified and identified in the equipment schedules within the stated internal and external ambient conditions.

Each AC unit shall be inclusive of all necessary components and controls to operate independently under a close control air conditioning regime.

Room side cooling medium shall be chilled water/direct expansion as specified in **Part 3**.

Heat rejection cooling medium for direct expansion systems shall be split air cooled/air cooled condensing unit/water/glycol as specified in **Part 3**.

2.12 PACKAGE AIR CONDITIONING UNITARY & FREE-STANDING

Humidification shall be evaporative/steam generator (electrode boiler) as specified in **Part 3**.

Heaters shall be electric multi-stage/LPHW as specified.

Controls & Alarms

Cabinet shall be provided with rigid frame and flush fitting removable panels to provide access to all parts of the unit for installation and servicing. Panels shall be lined with fire-resistant non-eroding insulation material which has both thermal and acoustic properties.

The electrical power/control panel shall be situated within the unit behind a hinged front access panel with interlocked isolator.

Cooling coils shall be multi-row copper tube aluminium fin construction, providing a large surface area with stainless steel drain trays incorporating factory fitted condensate traps.

Direct expansion units, where specified, shall have 2 No. independent circuits each provided with a filter dryer, sight glass charging connection, solenoid valve, thermostatic expansion valve and liquid distributor.

Chilled water units, where specified, shall have a factory fitted 3-way modulating valve incorporating a manual override facility, water pressure and temperature test points.

Fans shall be low speed DIDW fans with forward/backward curved impellers, sealed for life bearings and TEFC motors belt/direct drive unless otherwise specified in **Part 3**.

Fan performance shall be monitored by unit controls.

Electric heaters, where specified, shall be electric Incoloy sheathed elements with stainless steel fins balanced over 3 No. phases. They are to operate at black heat. Control shall be minimum two stages each protected by high temperature cut-out safety device.

LP Heaters shall be LPHW coils complete with 3-way modulating valve, water pressure and temperature test points.

Compressors shall be hermetic complete with back sealing isolating vales, crankcase heater and oil level sight glass. Protection shall be provided by an internal self-setting device, pressure relief and high/low pressure cut-out devices.

Compressor performance shall be monitored by unit controls.

Compressors shall be resiliently mounted on a robust frame supported on anti-vibration mountings to minimise noise and vibration transmission to the structure.

Water cooled condensers, where specified, shall have brazed plate heat exchangers with stainless steel pressed plates complete with two or three port pressure operated water valves to control head pressure.

Air cooled (remote) condensers, where specified, shall be matched to the compressor duty comprising weather-proof casing, rigid framework, galvanised steel base and channel feet.

Condenser coil shall be of multi-row copper tube aluminium fin construction.

Fan shall be direct of the driven axial type mounted on a galvanised diaphragm plate complete with wire fan guard.

The air cooled condensing unit shall be matched to the specified AC unit duty and be a self-contained weather-proof unit constructed as a rigid framework with galvanised steel base and channel feet complete with fully hermetic compressor, condenser coil and cooling fan.

2.12 PACKAGE AIR CONDITIONING UNITARY & FREE-STANDING

The compressor shall be fully hermetic type fitted with service stop valves, oil level sight glass, crankcase heater, high and low pressure safety cut-outs, internal re-setting overload device and pressure relief valve and all safety controls.

The compressor shall be provided with anti-vibration mountings and a flexible vibration eliminator shall be installed between the compressor and condenser coil.

Condenser coil shall be multi-row copper tube aluminium fin construction sized against the full cooling duty of the evaporator section plus the compressor heat. Condenser liquid and compressor suction pipes shall terminate in stub connections through a recessed galvanised service panel. Suction pipework shall be looped to prevent vibration damage.

Condenser fan shall be direct driven axial type mounted on a galvanised diaphragm plate.

Filters shall be fitted to intake/discharge side of the unit having an efficiency rating of 90% to Eurovent 4/5, unless otherwise specified in **Part 3**.

The humidifier shall be as specified in **Part 3** and the schedules and shall be of the electrode boiler type located out of the airstream incorporating proportional control, pre-settable maximum output, feed water conductivity sensing and micro-processor control with diagnostic facilities OR of the evaporative type located within the airstream incorporating feed water controls OR of a further type as specified in **Part 3**.

Controls shall be incorporated into the AC unit located in an easily accessible position behind a hinged front access panel with interlocking power isolator.

The controls shall be fully self-contained to provide independent operation of the computer room AC unit but with the facilities to interconnect with other units in a multi-unit installation or provide BMS interface and remote alarm functions.

Unit controls shall provide visual indication of the status and primary functions including:-

- Return air temperature.
- Relative humidity.
- Temperature and humidity set points.
- Power ON.
- Unit ON.
- Unit status, ie. cooling - heating - humidification - dehumidification.

and any others defined in **Part 3**.

Audible and visual alarms to be suitable for linking to BEMS system or remote alarm functions through volt free contacts:-

- High/low room temperature.
- High/low relative humidity.
- Airflow, cooling, heating or humidification failure.
- Dirty filter.
- Compressor HP or LP.
- Heaters over temperature.
- Faulty sensors.
- Microchip fault.
- Water detection (if fitted).

and any others defined in **Part 3**.

2.12 PACKAGE AIR CONDITIONING UNITARY & FREE-STANDING

WARRANTY OF AIR COOLING AND SPECIALIST EQUIPMENT

During the first year a fully comprehensive service contract (No charge for parts or labour) is to be provided. The contract will allow for 24 hr emergency cover (attend same day/ next day) and periodic maintenance visits in accordance with manufactures' recommendations. Service schedules and service months are to be included within the O & M manuals.

2.13 TERMINAL UNITS

FAN COIL UNITS

General

The duties, external pressure, air volume, water temperatures, acoustic and other particular requirements shall be as indicated in the schedules and **Part 3**.

The units shall be manufactured from a minimum of 1.2mm galvanised mild steel. The overall size of each unit shall be as detailed on drawings and specified in schedules.

Each model shall be type tested before leaving the factory to ensure it meets the specified performance.

All electrical components shall be tested at works to ensure each unit and its associated wiring complies with the BS 7671.

All bearings and moving surfaces in contact shall operate without requiring further lubrication.

Control Package

The units shall be either airside or waterside controlled as defined in **Part 3** and shall be arranged for analogue stand-alone controls or with a DDC control package suitable for linking to a BEMS system as specified in **Part 3**.

Airside Control

Where airside control is specified, each fan coil unit shall operate on either a draw through or blow through principle as defined in the schedules and in **Part 3** and the fan/s shall provide an even distribution of supply air across the coils. The heat exchange surfaces shall be sized to provide the cooling/heating outputs as detailed in the schedule. Temperature control shall be by modulation of the dampers, to maintain the required supply air temperature. The dampers shall provide tight shut-off, and incorporate a full by-pass zone between cooling and heating modes to avoid possibility of simultaneous cooling and heating operation.

The temperature controls shall be designed to operate at 24 Volts AC through a 240/24V transformer installed on each unit by Manufacturer.

The temperature control components shall comprise controller and air sensor.

The air sensor shall be fitted as specified in the schedules and **Part 3** in the return air stream/wall mounted/in ceiling via which the controller drives the actuator to modulate the dampers in sequence to maintain the required supply air temperature.

Waterside Control

Where waterside control is specified, each fan coil unit shall operate on either a blow through or draw through principle as defined in the schedules and **Part 3** and the fan/s shall provide an even distribution of supply air across the coils. The heat exchange surfaces shall be sized to provide the cooling/heating outputs as detailed in the schedule. Temperature control shall be by modulation of the control valves allowing either chilled or heated water to flow through the appropriate coil in the proportion necessary to maintain the required supply air temperature. The valves shall incorporate a full by-pass arrangement and an effective dead band to avoid simultaneous cooling and heating of the air.

The temperature controls are to be designed to operate at 24 Volts AC through a 240/24V transformer installed on each unit by the Manufacturer.

2.13 TERMINAL UNITS

The temperature controls components shall comprise valve actuators, modulating valves, controller, air sensor and 24 Volt AC transformer. These shall be provided and fitted by the Unit Manufacturer.

The air sensor shall be fitted as specified in the schedules and **Part 3** in the return air stream/wall mounted/in ceiling via which the controller modulates the valves to ensure the correct water quantity is passed through the coils to maintain the required supply air temperature.

Configuration

The fan coils shall be vertical in Builder's enclosure or cased; horizontal concealed or cased as defined in the schedules.

Vertical In Builder's Enclosure

The fan coil units shall be of the vertical mounted room uncased pattern suitable for installing within an accessible builderswork enclosure and shall comprise filter, vertical mounted cooling coil section, and/or heating coil section, fan and motor set and condensate drain pan. Discharge grilles to be provided in the Builder's casing. The Builder's casing must provide easily removable inadequate access to allow full maintenance.

Vertical in Manufacturer's Cabinets

The fan coil units shall be of the vertical mounted room pattern complete with a sheet metal cabinet with grilles and removable front panel for access, and shall comprise filter, vertical mounted cooling coil section, and/or heating coil section, fan and motor set and condensate drain pan.

Where specified, a valve box extension shall be provided to accommodate the valve package.

Horizontal Concealed

The fan coil units shall be of the horizontally mounted uncased pattern suitable for concealing above a false ceiling. They shall comprise filter, and as specified cooling coil with drain pan and/or heating coil. Adequate access to the units shall be provided.

The maximum depth of units shall be as defined in the schedules.

Horizontal Cased

The fan coil units shall be of the horizontal mounted room pattern complete with sheet metal cabinet with grilles and removable panel for access, and shall comprise filter, vertical mounted cooling coil section and/or heating coil section, fan and motor set and condensate drain pan. Where specified a valve box extension shall be provided to accommodate the valve package.

Components

Chassis

The chassis shall be manufactured from 1.2mm minimum galvanised mild steel and shall be sufficiently rigid to ensure the quiet and reliable operation of the unit.

The unit shall have a minimum of 4 No. slot type punched holes for securing unit to the wall or ceiling.

2.13 TERMINAL UNITS

Heat Exchangers

The coil/s shall be manufactured from solid drawn copper tubes mechanically expanded into accurately pre-formed collars in aluminium fins. The coil/s shall be single or multi-circuit water operation with headers. Each coil shall be fitted with manual radiator key pattern air vent and key operated drain cock.

All coils shall be factory tested to twice the working pressure as listed in the schedules. They shall be fitted with O/D plain copper tails.

Condensate Drip Tray

The condensate drip tray shall be manufactured from 1.2mm dipped galvanised mild steel welded at each corner. The tray shall be degreased before an anti-condensation insulation is applied to all internal and external surfaces. It shall be fitted with plain tail copper connection of minimum 15mm O/D.

The tray shall be fitted to ensure all condensate drains effectively from unit and shall extend under full coil width extending under control valves on water control units.

The drip trays shall be insulated with a material which shall have Class "O" fire rating.

Fan & Motor Assembly

Each fan and motor assembly shall be fitted with a high output permanent split-capacitor continuously rated motor with built in thermal overload protection complying with BS 2048:Part1:1961 and BS 5000. The motor frame shall be totally enclosed and fitted with maintenance free sealed for life sleeve bearings or ball race if external rotor motor. Motors shall be insulated to BS 2757 (Class B).

The fan scrolls shall be double inlet, double width, centrifugal type (or single inlet, single width when fans fitted on their side with external rotor motor), manufactured from mild steel with aluminium impellers.

All fan and motor assemblies shall be statically balanced to prevent the transmission of vibration and the complete assembly shall be fitted with neoprene rubber mounts.

Each fan coil unit shall be set to operate at 3 No. speeds, ie. low/medium/high, the speed control shall be achieved by variation of the voltage onto the fan motor, via a multi-tapped transformer provided by the Fan Coil Manufacturer.

A multi-speed control switch shall be mounted on the chassis or suitable for remote mounting as specified.

Filter

The filter shall be one of the following alternatives as specified later in **Part 3**.

Manufactured from a fine woven mesh of galvanised steel welded to a rigid galvanised steel frame, easily removable for cleaning.

OR

Manufactured from a woven glass fibre pad, which is replaced at regular intervals. The replaceable filter pad shall be held in a rigid sandwich frame manufactured from galvanised steel and is easily removable for changing the filter pad. The filter shall be to Local Authority approval.

Acoustic Lining

The unit shall be lined where appropriate, to meet the acoustic requirements, with Class "O" acoustic material to Local Authority approval.

2.13 TERMINAL UNITS

Discharge Plenum

The discharge plenum shall be manufactured from 1.2mm galvanised mild steel and shall be complete with discharge spigot/s as shown in schedules and on drawings.

Where specified in schedules, the plenum shall be acoustically lined with Class “O” acoustic material to Local Authority approval.

Inlet Spigot

Where an inlet spigot is specified, the air filter shall be arranged for bottom withdrawal unless otherwise specified in **Part 3**.

Test Pressure/Cleaning

All heat exchangers are to be factory pressure tested, chemically flushed and open ends sealed.

Electrical

The wiring in the units shall be arranged so that the major electrical components can be removed without disturbing the wiring. An electrical box shall be provided containing built-in switches and terminal block, with internal wiring terminating with fused connections.

VARIABLE AIR VOLUME TERMINAL

General

The VAV terminals shall be to the duties, turn down and acoustic performance indicated in the schedules.

The terminals shall be designed to be pressure independent unless otherwise specified and suitable for the inlet pressures indicated in the schedules.

Casing

The casing shall be manufactured from galvanised sheet steel of a suitable thickness to prevent drumming and meet the acoustic criteria, particularly on noise break-out.

The casing shall be acoustically lined with a suitable fire rated material to Fire Officer and Local Authority approval and shall be faced with a suitable Class “O” fire rated material to prevent migration of fibres into the air stream and the edges must be firmly sealed.

An access panel shall be provided on the underside of the unit which shall have quick release fasteners.

A circular spigot shall be provided on the inlet side of the unit. Holes for drop rods to support the unit shall be provided in the edge of the casing.

A galvanised sheet metal plenum box shall be provided on the discharge side of the unit as indicated in the schedules and shown on the drawings.

Controls

The box shall be complete with a packaged control unit which shall be capable of modulating the air volume in response to the dictates of the temperature and pressure sensors within the selected maximum and minimum volume settings of the particular box. The control package shall be installed within a protective metal cover. The terminals shall be shrouded.

2.13 TERMINAL UNITS

Where specified, the boxes shall be provided with a DDC control package suitable for interfacing with the BEMS control system as defined in the controls section of this specification. The controller shall be capable of modulating the air volume in response to the dictates of the temperature and pressure sensors within the selected maximum and minimum volume settings of the particular box.

Volume Control

An air flow star shaped, multi-point averaging sensor suitable for sensing pressure difference or air velocity measurement shall be provided.

Volume Flow Adjustment

The maximum and minimum volumes shall be calibrated and set at works in accordance with the box volumes shown in the Schedules.

Provisions shall be made for site adjustment of the maximum and minimum volumes.

Volume Settings

The maximum and minimum volumes shall be set up at works in accordance with the Schedules.

Reheater

Where specified, an LTHW heating coil shall be fitted to the discharge side of the unit. This shall be manufactured from aluminium fins mechanically bonded to copper tubes. The coils shall be pressure tested and degreased at works. The pipework open ends shall be sealed. Air vents and drain plugs shall be provided.

Temperature Sensor

The air sensor shall be fitted as specified in **Part 3** in the return air stream/wall mounted/in ceiling via which the controller modulates the valves to ensure the correct water quantity is passed through the coils to maintain the required supply air temperature.

SERIES FAN POWER VARIABLE AIR VOLUME TERMINAL

The VAV series fan power terminals shall be to the duties, turn down and acoustic performance indicated in the schedules and the acoustic section of this specification.

The terminals shall be designed to be pressure independent and suitable for the inlet pressures indicated in the schedules.

Casing

The casing shall be manufactured from galvanised sheet steel of a suitable thickness to prevent drumming and meet the acoustic criteria.

The casing shall be acoustically lined with a suitable fire rated material to Fire Officer and Local Authority Approval and faced with a suitable Class "O" fire rated material, also to Local Authority approval, to prevent migration of fibres into the air stream and the edges must be firmly sealed with metal angle capping.

An access panel shall be provided on the underside of the unit which shall have quick release fasteners.

A circular spigot shall be provided on the inlet side of the unit. Holes for drop rods to support the unit shall be provided in the edge of the casing.

A sheet metal plenum box shall be provided on the discharge side of the unit as indicated in the schedules and shown on the drawings.

Controls

2.13 TERMINAL UNITS

The box shall be complete with a packaged control unit which shall be capable of modulating the air volume in response to the dictates of the temperature and pressure sensors within the selected maximum and minimum volume settings of the particular box. The control package shall be installed within a protective metal cover. The terminals shall be shrouded.

Where specified, the boxes shall be provided with a DDC control package suitable for interfacing with the BEMS control system as defined in the controls section of this specification. The controller shall be capable of modulating the air volume in response to the dictates of the temperature and pressure sensors within the selected maximum and minimum volume settings of the particular box.

Volume Control

An approved air flow star shaped, multi-point averaging sensor suitable for sensing pressure difference or air velocity measurement.

Volume Flow Adjustment

The maximum and minimum volumes shall be calibrated and set at works in accordance with the box volumes shown in schedule.

Provisions shall be made for site adjustment of the maximum and minimum volumes.

Reheater

Where specified, an LTHW heating coil shall be fitted to the discharge side of the unit. This shall be manufactured from aluminium fins mechanically bonded to copper tubes. The coils shall be pressure tested and degreased at works. The pipework open ends shall be sealed. Air vents and drain plugs shall be provided. The coil duties and water temperatures shall be as set out in the schedules.

Temperature Sensor

The air sensor shall be fitted as specified in the return air stream/wall mounted/in ceiling via which the controller modulates the valves to ensure the correct water quantity is passed through the coils to maintain the required supply air temperature.

Fan & Motor Set

The fan shall be of the forward curve centrifugal pattern manufactured from galvanised sheet metal and mounted on vibration isolation pads. The fan shall be driven by a direct motor of the permanent split capacitor. This shall be operated by a stepless fan speed controller. The fan shall be capable of manual volume adjustment at site. All earthing and wiring to conform to IEE Regulations.

Low Temperature Air

Where specified, the unit shall be designed for low temperature air application and suitable for the supply air temperature indicated in the schedules.

Filter

A dry fabric filter shall be provided in the air inlet from the ceiling void. This shall comply with the Local Authority and Fire Officer requirements. They shall be Grade 3 when tested in accordance with BS EN 779.

2.14 PUMPS

GENERAL

The pumps shall perform to the duties and be to the types as defined in the schedules and **Part 3** of this specification.

Pumps shall be installed in accordance with the Manufacturer's recommendations and shall comply with the requirements of BS 1394:Part 1, BS 4082:Part 1 and Part 2 and BS 5257 as applicable. They shall be type tested in accordance with BS 5316:Part 1. Pump curves shall be submitted to indicate performance under all likely operating conditions.

Pump casings and seals shall be suitable for the total of the system maximum operating pressure, plus the pump maximum generated head at the maximum operating temperature as defined in **Part 3** of the specification and on the schedules.

Close-coupled pumps shall be arranged such that the failure of a pump seal shall not result in damage to the drive motor.

Floor mounted pumps shall be set on a prepared base with the appropriate anti-vibration facilities ensuring that it is properly levelled before finally fixing down. Connections shall be screwed to BS 21 for sizes up to 40mm and flanged to BS 4504 to suit the system maximum pressure on sizes 50mm and above.

Connecting pipework shall be arranged to ensure that no stresses are transmitted to pump casings.

Each pump shall be fitted with an isolating valve and flexible connection on suction and discharge connections, a drain plug and, except where the pump is inherently self-venting, an air release cock.

Unless otherwise indicated, pump shaft speed shall not exceed 24RPS.

Pressure gauges shall be connected to the main on each side of the circulator.

Where duplicate pumps are provided, the gauges shall be connected to the common suction and delivery mains, and shall be mounted at the same horizontal level. Where stand-by pumps are indicated with automatic changeover, non-return check valves shall be incorporated in each discharge line. Test points to be provided at inlet and outlet flanges of each pump.

Where specified in **Part 3** of the Specification, each pump shall be provided with inverter speed control to allow the pump to operate down to 20% of its full duty and shall be selected to give stable control over the whole operating range. They shall meet the requirements of European Legislation relating to electro-magnetic compatibility. The Manufacturer shall provide facilities to block out any speeds at which the pump is in resonance with the forcing mechanism. The relationship between voltage and frequency shall be matched to the pump absorbed power requirements.

MOTORS

These shall be cage rotor type, maximum continuous rating and manufactured to comply with BS 5000:Parts 10 and 99 for output and performance, and to comply with BS 4999:Parts 105 and 141 for degree of protection and dimensions.

The enclosure shall be TEFV, IP54 as a minimum, with Class 'F' insulation as a supply, or 1-phase 50Hz 240V supply is acceptable for motors up to 0.37kW or as defined in **Part 3** of this specification and shown on the drawings and schedules.

Motors shall be designed to operate within Class 'B' temperature limits, but where inverters are to be used then the motor power shall be adequately derated and the derated power shown on the motor nameplate and the motor may then operate within Class 'F' temperature limits.

Motor nameplate power rating shall allow a margin for 10% increase in pump flow rate on the selected performance curve and shall also allow for a 20% increase in pump generated head through fitting a larger impeller or through a pulley drive speed increase.

2.14 PUMPS

Inverter Drive Pumps

Pump, inverters and operating software must be sourced from one manufacturer, and must be compatible with the building management system in operation throughout the university.

Pressure sensors linked to the university building management system are to be installed on all systems to allow remote monitoring of the flow settings. (Only exception of this is for systems designed to operate at maximum speed at all times).

Pump sets must be configured to allow duty lead / lag pump control via the BMS system

Pump commissioning settings and results are to be included in the O&M manuals and must be available at handover.

A remote hand held operating controller is to be supplied for all pumps made by a different manufacture.

Where a direct drive pump is replaced with an inverter drive type then both the supply and control wiring is to be modified to meet the pump control and monitoring requirements.

Commissioning of twin head inverter driven pumps must include setting values on both pumps, run and stand by.

On completion of commissioning the pump manual control buttons MUST be disabled to prevent unauthorised intervention.

Where inverters are to be used, then the motor nameplate power rating shall be suitable for the maximum pump duty as defined in **Part 3** of this specification and shown on the drawings.

Energy efficient motors shall be used where defined in **Part 3** of this specification.

Motors shall be suitable for starting by direct-on-line starters and also suitable for starting by star-delta starters at 4kW and above, the actual method used shall be as defined in **Part 3** of this specification.

LTHW/MTHW, CHILLED WATER, CONDENSER/COOLING WATER & DHWS SYSTEMS

Pumps shall be of the following types or as defined in **Part 3** of this specification and shown on drawings and schedules.

Centrifugal Pumps

Pumps shall comply with BS 4082 or BS 5257 as appropriate. Shafts and impellers shall be corrosion resistant. Shaft extensions shall have a liquid shield. Cast iron casings shall have a liquid shield. Cast iron casings shall not be subjected to a pressure in excess of 15 bar gauge. Impellers shall be selected and trimmed to the specific duty and balanced to Balanced Quality Grade G6.3 of BS 5265:Part 1.

Installations shall include suction and discharge taper pieces where necessary. Packed gland wells shall be piped to a drained open tundish adjacent to the pump base.

Unit constructed close coupled pumps shall be of the back pull-out type, enabling the motor, drive and impeller to be withdrawn from service without disturbing the volute casing, connections, piping etc.

Bearing shall be ball or roller type, either sealed for life or with grease lubricator. The bearings shall be outside the seal box and shaft seal (on HTHW positive lubrication must be used).

Direct driven pumps and their drive motors shall be mounted on a common bedplate.

In-Line Pumps (Centrifugal)

2.14 PUMPS

Pumps shall be fitted with mechanical seals unless otherwise indicated. Eccentric reducers or taper pieces shall be fitted at suction and discharge connections where pump connection sizes differ from pipeline size. Pumps shall be suitable for mounting on a prepared base with foundation bolts or pipeline mounted as specified in **Part 3** and on the schedules.

The pumps shall be suitable for mounting with shafts vertically or horizontally as shown on drawings and schedules and must be installed strictly in accordance with the Manufacturer's requirements.

Twin Pumps (Centrifugal)

Twin pumps set comprise direct coupled in-line pumps connected in parallel with common inlet and outlet connections. The assembly shall incorporate non-return check valves to isolate the stationary pump. Twin pump sets shall be suitable for mounting on a prepared base with foundation bolts or on wall brackets or pipeline mounted as described in **Part 3** and on the schedules. Impeller and motor assemblies shall be readily removable and a blanking flange shall be provided.

Canned Rotor Pumps

Canned rotor and glandless pumps up to 2kW input power shall comply with BS 1394:Part 1.

All canned rotor pumps must be mounted with shafts horizontal and in accordance with Manufacturer's instructions.

HTHW SYSTEMS

Pumps shall be a centrifugal type with direct or approved indirect drive and taper connections where necessary on suction and delivery ports. Directly driven pumps shall be mounted on a common bedplate. Pumps shall have cast steel or SG iron bodies, corrosion resistant steel shafts and nickel-iron impellers. The housing of the stuffing box and shaft seal shall be arranged for water cooling and shall be complete with cooling water connections.

Details of cooling water requirements to suit the pump running temperature shall be supplied by the Pump Manufacturer and the Installer shall supply and install all pipework and equipment to complete the installation.

Inlet and outlet ports shall be flanged and provided with taper connections if necessary.

Bearings shall be either sleeve type with oiling ring and reservoir, or ball or roller type with grease lubricator. The bearings shall be outside the stuffing box and shaft seal.

BOILER FEED PUMPS

Feed pumps shall be electrically driven centrifugal type, horizontal or vertical pattern as specified on schedules and arranged for direct drive through a coupling. In the case of a horizontal pattern pump, the pump and motor shall be mounted on a common bedplate. The pump sets shall either be supported on a base or alternatively they may be integral with a packaged steam boiler. All parts of the pumps in contact with condensate shall be of corrosion resistant material.

- Shafts shall be corrosion resistant. Dripless mechanical shaft seals shall be limited to system temperatures below 145°C. Where packed glands are provided, hardened steel shaft sleeves shall be fitted. Where a lantern ring is specified, it shall be non-metallic. Gland packing material and construction shall be suitable for the operating conditions. Packed glands shall be provided with separate drip pipes, run to discharge visibly over a tundish or water sump.
- Bearings shall be ball or roller type, either sealed for life type or with grease lubricator. The bearings shall be outside the stuffing box and shaft seal.

2.14 PUMPS

Inlet and outlet ports shall be flanged and provided with taper connections. Each pump shall be installed with isolating valves on the suction and delivery sides and, when not supplied as an integral part of a packaged steam boiler, shall be mounted on a prepared base.

CONDENSATE PUMPS & RECEIVER SETS

Pumps shall be electrically driven centrifugal type, unless otherwise indicated, arranged in duplicate with automatic changeover. Pump casings shall be of cast iron or gunmetal as indicated. Shafts shall be corrosion resistant and impellers shall be of gunmetal.

The design of the pumps and the installation shall be such that condensate at temperatures up to 95°C can be handled without damage occurring due to cavitation.

The pumps may be of the horizontal or vertical type, resiliently connected, direct coupled. They shall be mounted on a common bedplate or chassis. Shafts shall be corrosion resistant. Where packed glands are provided, hardened steel shaft sleeved shall be fitted. Where a lantern ring is specified, it shall be non-metallic. Gland packing material and construction shall be suitable for the operating conditions. Packed glands shall be provided with separate drip pipes, run to discharge visibly over a tundish or water sump.

Bearings shall be ball or roller type, sealed for life type or with grease lubricator. The bearings shall be outside the seal box and shaft seal.

Inlet and outlet ports shall be flanged.

Each pump shall be installed with isolating valves on the suction and delivery sides and shall be mounted on anti-vibration mountings where indicated. Condensate receivers shall be of stainless steel or heavy gauge welded steel or copper construction, and shall be supported on a steel base. Steel receivers shall be painted internally and externally with two coats of anti-corrosive solution.

Pumps shall be selected with due account of the low system Net Positive Suction Head (NPSH) available so as to avoid cavitation when operating at a temperature of 95°C.

Each receiver shall be complete with the following:-

- A bolted access cover.
- A condensate level gauge glass.
- Draining cock or valve.
- Connections for condensate return and pump suction.
- Separate vent and overflow pipes not less than 40mm size and so arranged that the discharge will avoid structural damage or injury to personnel.
- High and low water level pump control gear.
- Each receiver shall have a purpose-built support frame made from mild steel, galvanised after assembly.
- Sheet lead pads shall be fitted on the bearing surfaces of all copper receivers.

SEMI-ROTARY HAND PUMPS

Semi-rotary pumps shall be manufactured from materials suitable for the particular requirements, but those used for the drainage of boiler houses and plantrooms shall be suitable for use with hot water at temperatures up to 98°C. For the drainage of oil storage catchpits, shaft seals of the "O" ring pattern shall be used. Pumps shall be provided with a foot valve and strainer and shall be fixed securely in a position which allows for ease of manual operation.

2.14 PUMPS

OIL CIRCULATING & OIL TRANSFER PUMPS

Oil pumps shall be electrically driven positive displacement screw or gear type, or for use with BS 2869 Class D oils, they may be of centrifugal type. They shall be suitable for the viscosity and temperature of the grade of oil to be pumped. Isolating valves shall be provided on the suction and discharge sides of each pump. An internal pressure relief valve shall be fitted to positive displacement pumps. Pumps for transferring oil from a main tank to a service tank shall be started manually and switched off automatically by means of a float switch fitted in the service tank. Each floor mounted circulating set shall be mounted on a prepared base.

DOMESTIC WATER BOOSTING PUMPS

Sets to comprise 2/3 No. pumps as defined in **Part 3**, manifolds with isolating and non-return valves, pressure switches, gauge and relief valves, all mounted onto a combination bedplate.

The set is to be so designed that on 2 No. Pump sets each pump shall be capable of the full system duty and on 3 No. Pumps sets each pump is capable of 50% of full duty, the third pump on these sets being a stand-by to the other two.

With the control switches set to automatic, a small demand by the system will be met from the vessel. As the demand increases, the "run" pump will start and continue to operate whilst there is a demand from the system. When the demand ceases, the system will re-pressurise and the pump will cut out.

To obviate the possibility of the pump "hunting", minimum run time relays are fitted into the control panel to override the pressure switches.

The duty and stand-by pump/s can be alternated by the selector switch on the control panel.

Control Panel

These are pressed steel construction, damp and dustproof IP55 fitted with Test/Off/Auto switches and Run/Trip lamps for each pump, selector switch, low water and panel energised lamps, lockable door, door interlocked isolator, HRC fuses for motors and control circuit, motor starters and overloads along with terminals and labels. Panels are to be made suitable for 35°C ambient temperature unless otherwise specified.

SUMP PUMPING EQUIPMENT

General

Clear water and sewage pumping equipment shall be provided as specified and comprise duty and stand-by equipment, each pump having a duty commensurate with the drainage of the facilities served and installed in accordance with the installation instructions of the Manufacturer.

Control shall be by means of floats or probes and provide an alarm to an agreed point in the event of the inflow into the sump exceeding the rate of pumped outflow. Pump operation shall be so arranged that in the event of the duty pump failing to cope with the sump inflow, both pumps will operate together. A facility shall be incorporated to manually or automatically alternate the duty and stand-by pump operation as indicated in the Schedules.

Incorporated within the control panel a set of volt free contacts shall be provided for indication of operation and alarms. Indication shall also be included on the panel by means of pilot light showing particular mode of operation.

Control panels shall be constructed to BS.5486 Factory Built Assemblies of Switch Gear & Control Gear, incorporating British Standard wiring and components and complying with BS.7671.

Sewage Pumping Equipment Submersible Installation

2.14 PUMPS

Duplicate set of submersible sewage pumps shall be provided as specified in **Part 3**. Pumps shall be of cast iron casing and impeller construction with automatic coupling pedestals bolted to the sump floor and directly connected to the pumped discharge line. Raising and lowering of the pump and its motor assembly to and from the coupling pedestal shall be achieved by means of lifting chain and fixed single or dual guide rails. Pump motors shall be enclosed within watertight cast iron housing sealed to the pump casing. Motors shall be suitable for intermittent/continuous running and provided with built-in temperature sensors to give warning of an overheating situation developing and to ultimately switch of the affected unit to avoid damage to the windings. Rotor shaft should rotate in lubricated maintenance-free bearings.

Discharge pipework from each pump assembly shall be individually fitted with a non-return valve and isolating valve, the locations of which shall be above and clear of the sump top water. Valves shall be so positioned as to permit reasonable access for inspection and operation. Size and position of access into the sump shall be in compliance with Manufacturer's recommendations. Sumps shall be fitted with bolted airtight inspection covers and frames to suit likely superimposed loads.

A remote metal (or equal approved) clad wall mounted control panel with hinged access shall be supplied to give fully automatic operation, with a manual override facility, in conjunction with sump located electrodes, floats or electro-pneumatic level controls to stop and start pump operation. The control shall provide for duty or stand-by pump operation and two pumps operating together should the duty pump fail to meet the demand. An additional control shall give audible warning that a high water level situation has developed in the sump. An automatic/manually operated changeover switch shall alternate duty and stand-by pump operation. The panel shall incorporate run and fault lights and facilities for remote fault and alarm condition indication by either volt-free contacts or otherwise as described in **Part 3** and in the schedules.

Pump and motor assembly shall be fitted with multi-core heavy duty flexible water-proof cable and water-proof cable inlet, strain relief and anti-kink guard.

On completion of the installation and clearing the sump of all debris, water shall be admitted to the sump and the working of all control sequences and alarms checked for their correct operation, together with confirming pump and discharge line performance.

Sewage Pumping Equipment Dry Well Installation

Duplicate set sewage pumps for vertical/horizontal dry well installation shall be provided as specified. Pumps shall be of cast iron casing and impeller construction, mounted on ductfoot bend/volute support as appropriate, and bolted to dry well floor. Connection between wet sump and pump suction shall incorporate cast iron puddle flange and flanged gate valve to each pump assembly. Pump motors shall be suitable for operation within an enclosed space, intermittent/continuous running and provided with built-in temperature sensors to give warning of an overheating situation developing and to ultimately switch off the affected unit to avoid damage to the windings.

Discharge pipework from each pumping assembly shall be individually fitted with non-return valve and isolating valve, the location of which should be above and clear of the wet sump top water level. Valves shall be so positioned as to permit reasonable access for inspection and operation. Size and position of access to the dry sump shall be in compliance with Manufacturer's recommendations. Sumps shall be fitted with bolted inspection covers and frames to suit likely superimposed loads.

The wet well shall be fitted with bolted and airtight access facilities to permit entry for cleaning/maintenance purposes of the sump and its water level control system.

The dry well shall incorporate a sump receiving spillage from maintenance operations and into which a single waste water submersible pump having integral level controls shall be located. Pump discharge line incorporating an isolating and non-return valve shall connect into the main sewage pump discharge line at an elevated position. Operation of the pump shall be independent of main sewage pumps and incorporate a high water level audible alarm.

A metal (or equal approved) clad wall mounted control panel with hinged access shall be supplied and installed external to the dry wall, to give fully automatic operation of the sewage pumps, with a manual override facility.

2.14 PUMPS

This shall operate in conjunction with wet sump located electrodes, floats or electro-pneumatic controls to stop and start pump operation.

The control shall provide for duty or stand-by pump operation and two pumps operating together should the duty pump fail to meet the demand. An additional control shall give audible warning that a high water level situation has developed in the wet sump. An automatic/manually operated changeover switch shall alternate duty and stand-by pump operation. The panel shall incorporate run and fault lights and facilities for remote fault and alarm condition indication.

Pump and motor assembly shall be fitted with multi-core heavy duty flexible water-proof cable and water-proof cable inlet, strain relief and anti-kink guard.

On completion of the installation and clearing of wet and dry wells of all debris, water shall be admitted to the wet well and the working of all control sequences and alarms checked for their correct operation, together with confirming pump and discharge line performance. The sump in the dry well shall be similarly treated to confirm sump pump operation.

2.15 PRESSURISATION PLANT

PRESSURISATION UNIT/S

The pressurisation units shall be as defined in **Part 3** of this specification and in the schedules.

They shall have an electrical control system of the fail safe type, electrically interlocked with the heat or chiller source, incorporating an integral alarm system.

The pressure vessel is to be hydraulically tested at the Manufacturer's works to twice the normal working pressure or 10 bar, whichever is the greater.

The system pressure will be maintained between safe limits by a packaged set to suit the system data as scheduled comprising:-

- Expansion vessel/s with replaceable diaphragm.
- Stove enamelled steel enclosure with hinged lockable door having interlocked isolator.
- Break tank with close fitting lid, ball valve, Type "A" air gap, overflow and suction strainer.
- Duplicate fill pumps with cage motor and bronze body fitted with suction and discharge isolating valves. Pumps arranged for auto changeover on fall in pressure or pump tripped. Motors protected by miniature circuit breakers.
- System isolating valve to enable commissioning of the set prior to opening up the system.
- A pressure transducer.

The set will be controlled by a programmable microprocessor which will, on demand, indicate the following on the fascia:-

- System working pressure.
- Cold fill pressure setting.
- High pressure alarm setting.
- Low pressure alarm setting.
- Minimum pump running time.

AND

Will indicate the following alarm conditions through volt free contacts:-

- High system pressure.
- Low system pressure.
- System leakage/frequent pump starting.
- Transducer failed.
- Running and tripped lights for each pump power on light.
- The duty pump will be alternated after each cycle.
- Under voltage protection provided.
- No. 1 pump tripped.
- No. 2 pump tripped.
- Break tank low level.

MOTORS

All motors are to be to BS 5000:Part 10 and BS 4999 and without shaft extension. Minimum IP54 enclosure and Class "F" insulation. Energy efficient motors where defined in **Part 3**.

2.17 DUCTWORK

The ductwork systems shall be installed in accordance with the following specification and any further requirements included within **Part 3** of this specification or detailed on the drawings

GENERAL

The Ductwork Contractor shall be responsible for checking on site the as built building profiles and details of other services on site before the fabrication of ductwork is commenced.

Internal roughness and obstruction to airflow (other than dampers, vanes etc.) or sharp edges or corners on the outside of ductwork, flange supports etc., will not be accepted.

Constructed using WRC approved sealants, gaskets, joints, adhesives etc., which will not support bacterial growth and which produce minimal fire or smoke hazards if involved in a fire. This to include attachments such as grilles etc.

Fire stopped around the perimeter of ductwork penetrating fire compartments unless specifically stated in **Part 3** of this specification.

Provided with weather-proof collars where roofs or external walls are penetrated.

Installed to avoid any collection of water. Drainage pipework will be by others, ie. not in the ductwork contract.

Attention is to be paid to the making and sealing of joints in ductwork, particularly where these occur on the blind side of a duct or are subsequently obscured by other parts of an installation or building fabric etc.

Run generally parallel with walls and ceilings in order to circumvent building projections or pass through structures where permitted as shown on the drawings.

Installed where practicable with not less than 100mm space between wall, ceiling or floor and finished face of duct or insulation for cleaning purposes.

SHEET METAL DUCTWORK

General

All ductwork and associated materials shall be manufactured, installed and tested, in accordance with the current edition of HVCA Specification (DW/144), for sheet metal ductwork, for low, medium and high pressure/velocity air systems

The classes to be used on any system shall be as scheduled in **Part 3** of this specification.

Where black steel is specified, it shall be cold reduced steel sheet to BS 1449:Part 1, Grade CR4 GP or equal.

Stainless steel construction and grade as specified in **Part 3** using thickness as for mild steel.

Aluminium construction and grade as specified in **Part 3** using thicknesses to DW/144.

Where ductwork passes through fire barriers the thickness of sheet must be approved by the Building Control Officer.

LEAKAGE TESTING OF DUCTWORK SECTIONS

Shall be:-

Carried out by the Ductwork Contractor generally in accordance with DW/144 and DW/143 as appropriate
The results to be recorded on test sheets based on DW/144 and DW/143 examples and compared to acceptable leakage rate specified.

2.17 DUCTWORK

Sections which needs unacceptable levels of remedial work on seams or joints are to be replaced by new sections, this requirement to be identified during the preliminary test to DW/143, paragraphs 4.9 and 4.10.

All "in duct" plant to be factory tested to the same leakage classification by the Manufacturer.

LEAKAGE CHECKS ON COMPLETED SYSTEMS

Shall be:-

Carried out when the fan has been first set to work and a visual/audible inspection made of all connections from plant to ductwork including any untested joints between tested sections and all joints and seams not previously subjected to leakage pressure tests, including plant casings, grille joints, dampers etc.

FITTINGS

Standard arrangement to DW/144 wherever possible.

Arranged with vanes in the bends of rectangular sub-branches connecting directly to grilles and diffusers.

Square bends (when shown on drawings) shall be fitted with Aerofoil section turning vanes mounted in runners and rigidly fixed to the inside of the duct as specified in **Part 3**, for bends below 300mm; and to DW/144.

Bends and off-sets to have a minimum throat radius equal to half the width of the duct unless specified elsewhere.

SUPPORTS & HANGERS

Supports and hangers generally to DW144.

Where cantilever brackets or other special forms of support are indicated, they shall be structurally strong enough to take the load and to transfer the imposed load to the building structure. The design and supporting calculations shall be provided to the Engineer prior to manufacture.

The ductwork hangers to be galvanised, adjustable and have, between the hanger and the ductwork, a gasket to prevent metal to metal contact.

On the fresh air inlet and cooled supply air systems the thermal insulation will have a vapour barrier. The hangers in this case shall conform to DW/144 and include all necessary components to maintain the vapour barrier.

ACCESS OPENINGS, PANELS & COVERS

Access doors, panels and covers other than those regarded as standard practice (see DW/144) will be marked on the contract drawings or listed in **Part 3**, including type to be used.

Details of large access openings shall be agreed with the Engineer.

They shall be:-

Fitted in readily accessible locations and suitable for the purpose.

Provided to the sizes, requirements and positions recommended in DW/144 and in **Part 3** of this specification and on the drawings, utilising suitable proprietary products, which meet the relevant pressure classifications.

Provided adjacent to filters, cooling coils, fan, heating coils, humidifiers, and **all** dampers including fire dampers to facilitate easy cleaning and maintenance.

Sealed, to ensure an airtight seal with a soft neoprene full-face gasket secured to the ductwork with an approved adhesive.

2.17 DUCTWORK

VOLUME CONTROL DAMPERS

Air dampers shall be provided where indicated on the drawings or called for elsewhere in the specification. The Contractor shall ensure that sufficient dampers shall be provided to regulate and balance the system. Dampers on grilles or diffusers shall be used **only** for fine or secondary control. All dampers shall be sufficiently rigid to prevent fluttering.

Dampers shall be of the Aerofoil blade (double skin) multi-leaf opposed blade type (unless otherwise specified) with the blades rigidly fixed to the horizontal spindles.

Dampers constructed by the Contractor shall conform to the requirements of DW/144.

Alternatively, when specified, proprietary damper units may be used. The type and manufacture of such dampers shall be agreed with the Engineer. Dampers shall incorporate a lock-in device and blade position indication. A sample shall be submitted of the proposed dampers prior to the commencement of the installation when specified.

Single blade up to 200mm ducting height, elsewhere multi-blade, opposed blade type with each blade not exceeding 175mm in width not longer than 1200mm.

All volume control dampers (not fire dampers and self-closing dampers) shall be fitted with locking devices and position indicators.

After final balancing the quadrant shall have a small "V" shaped notch, filed in the quadrant, indicating the centre line of the lever when in the operating position,

Each damper shall have an adjacent access or inspection door so that the operation of the blades may be observed.

Motorised dampers, where specified, shall be suitable for 24V on-off reversible motor with manual override facility and shall generally be to the above requirements and installed where shown on the drawings and as scheduled in **Part 3**. Damper motors, thrusters, positioners and remote operating gear where specified shall be rigidly mounted on purpose-made brackets and careful aligned.

All damper gear shall be suitable for operation over the pressure and temperature range of the medium being controlled.

Where dampers are required to operate to a fully closed position, dampers shall be of the low loss type, ie. not to exceed 5% of the maximum design air flow in the duct.

On insulated ducts, the damper actuator quadrant and linkage shall be located proud of the external face of the duct insulation.

Where butterfly dampers are specified, they shall be of two plates, edge seamed, the same thickness of material as that from which the associated duct is made, rigidly fixed to each side of mild steel operating spindle, the ends of which shall be turned and housed in non-ferrous bearings.

FIRE DAMPERS

Fire Dampers

Fire dampers shall be supplied and fixed with installation mounting frames which conform to the prevailing Building Regulations and be acceptable to the District Surveyor/Building Control Officer and Fire Officer, in accordance with DW/144.

The construction shall allow for all additional framing supports and bracing as may be necessary to adequately attach the fire dampers to the structure. The assembly to be approved by the Building Control Officer, District Surveyor and Fire Officer.

2.17 DUCTWORK

Each fire damper and installation mounting frame shall have at least the same standard of fire resistance as the wall or floor through which the duct passes. Unless otherwise indicated it shall have a minimum fire resistance rate of 2 hours to the dynamic heated gas flow tests of EN1366-2 Classification ES and to BS 476 Part 8/20. When a fire resistance rating of 4 hours is required either two dampers factory assembled in series or a single damper having a fire resistance rating of 4 hours certified by an approved Testing Authority shall be provided.

All fire dampers must be provided with the shutter blades located outside the airstream (unless otherwise specified). Each damper shall have a stainless steel curtain in a welded galvanised steel casing with stainless steel side seal gaskets. The damper blade curtain shall be held in the folded position by a dual safe thermal actuator and fusible link.

All damper blades shall be tensioned to ensure instantaneous closure on thermal activation at 72°C unless specified elsewhere. A self-latching reset mechanism shall be provided for easy re-setting of the damper curtain.

The Ductwork Sub-Contractor shall obtain and issue proof of the necessary approvals of the fire dampers to the Contractor.

The Contractor shall be responsible for ensuring the inspection and testing of all fire dampers installed in the contract is carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the Manufacturer's data sheets.

Access panels with chains shall be provided adjacent to the access side of all fire dampers.

In no instances shall flexible duct connections be allowed on to fire dampers or through floors and walls.

Combination Smoke/Fire Dampers

Smoke/fire dampers shall be supplied and fixed with installation mounting frames which conform to the prevailing Building Regulations and be acceptable to the District Surveyor, Building Control Officer and Fire Officer, in accordance with DW/144.

The construction shall allow for all additional framing supports and bracing as may be necessary to adequately attach the fire dampers to the structure. The assembly to be approved by the Building Control Officer, District Surveyor and Fire Officer.

Each smoke/fire damper and installation mounting frame shall have at least the same standard of fire resistance as the wall or floor through which the duct passes. Unless otherwise indicated it shall have a minimum fire resistance rate of 2 hours to the dynamic heated gas flow tests of EN1366-2 Classification ES and to BS 476 Part 8/20. When a fire resistance rating of 4 hours is required either two dampers factory assembled in series or a single damper having a fire resistance rating of 4 hours certified by an approved Testing Authority shall be provided.

All smoke/fire dampers must be of the multi-blade type with interlocking stainless steel Aerofoil blades in an all welded galvanised steel casing. The blades shall be held in the open position by an electrical power supply and thermal sensor incorporated within the control mode.

Upon activation of the thermal sensor at 72°C, unless specified elsewhere, or removal of the power supply to the damper control mode, the damper blades shall instantaneously close and interlock to provide tight smoke sealing and fire control.

All dampers shall be remotely reset by restoration of the power supply unless the thermal sensor has been activated. Each damper control mode shall have interface facilities to operate as commanded by a dedicated fire/smoke control panel within the building. Power supply shall be 24V AC or 220/240V AC as specified within **Part 3**.

2.17 DUCTWORK

The Ductwork Sub-Contractor shall obtain and issue proof of the necessary approvals of the smoke/fire dampers to the Contractor.

The Contractor shall be responsible for ensuring the inspection and testing of all smoke/fire dampers installed on the contract is carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the Manufacturer's data sheets.

Access panels with chains shall be provided adjacent to the access side of all smoke/fire dampers.

In no instances shall flexible duct connections be allowed on to smoke/fire dampers or through floors and walls.

FLEXIBLE DUCTWORK

Flexible ducts shall be manufactured from light gauge metal helically wound with lock seams of circular section.

The Contractor shall ensure that the Ductwork Sub-Contractor obtains and issues proof of the necessary Building Control and Fire Officer approvals for the use of the flexible ductwork to be installed.

Flexible ductwork used to make final connection between distribution ductwork and terminal units only shall be kept as short and straight as possible and shall not be used to take up gross misalignment. Flexible duct shall be adequately supported to eliminate sagging. The length of flexible ducting use shall be approved by the Building Control Officer, Fire Officer and Designer.

Where the flexible ductwork is to be insulated, this shall be factory applied of a type approved for the application and to the thermal conductivity equivalent to the adjacent thermal insulation, and shall be Class "O" fire rated.

The frictional resistance to air flow per unit length of the flexible duct shall be agreed with the Engineer. The radius ratio R/D for bends shall not be less than 2, where R is the centre line radius and D is the diameter of the flexible duct.

It shall be to a standard of air tightness equal to that of the ductwork.

Constructed to meet the fire precautions recommended in BS 5588 which comprise:-

- Length of flexible ductwork branches not to be longer than 1m or pass through fire compartment walls, partitions, floors or enclosures of sub-compartment walls or enclosures, or cavity barriers.
- Fire resistance to meet BS 476:Part 6 with indices of performance not more than I equal to 12 and 1 equal to 6.
- Materials shall not produce smoke or toxic fume hazards if involved in a fire.
- Flexible ducts shall be suitable for an operating temperature range of 18°C to 120°C.
- The joints to rigid spigots shall be sealed with a jointing paste or mastic compound. Ducts up to 150mm dia. shall be secured with a worm drive type hose clip complying with BS 3628. Ducts over 150mm dia. shall be secured with a band clip.

FLEXIBLE JOINTS

Flexible joints shall be provided on fan inlet and outlet connections at building movement joints and elsewhere on the ductwork where indicated on the drawings. They shall be of the full cross-sectional area of the mating fan inlet or outlet duct section. The ends of the ducts or the duct and the fan connection shall be in line and without undue deflection or slackness.

2.17 DUCTWORK

Flexible joints on other fan inlet connections shall be between flanged ends. The flexible material flange shall be backed by an angle or flat iron flange and the flexible joints shall be securely held between the metal flanges. Flat iron bands used with fan inlets shall be not less than 5mm thick.

Flexible joints shall be equal in cross-section to the points of connection and not longer than 250mm or less than 50mm.

Flexible joints shall be of “Neoprene” coated glass fibre or other materials specified in **Part 3** (excluding asbestos) and have fire resistance properties of 30 minutes integrity to BS 476:Part 8, Class 1 surface spread of flame to BS 476:Part 7 and not produce smoke or toxic fume hazards if involved in a fire, to Fire Officer/Building Control approval.

SEALANTS & GASKETS

All sealants and methods of jointing must be acceptable and comply with the prevailing Building Regulations and approved by Building Control Officer.

Gaskets or preformed strips must be of an equivalent width to the faces of joint flanges.

The use of self-adhesive tape shall not be permitted.

PROTECTIVE FINISHES

Paint all bare edges and bare metal with two coats of zinc rich paint.

Any other special finishes shall be as defined in **Part 3** of this specification.

ACOUSTIC LINING

As defined in the acoustic section of this specification.

Lining must comply with the Building Control Office and Fire Officer approval.

EXTERNAL DUCTWORK

External ductwork shall be constructed from a 1.6mm black mild sheet minimum and externally painted with a suitable material OR galvanised after manufacture.

All ductwork shall be flanged and all nuts, bolts and fixings shall be bright zinc plated.

All supports shall also be constructed from mild steel sections and galvanised after manufacture.

Particular care shall be taken in selecting structural fixings that will provide a life-cycle appropriate to the buildings intended use. All supports and fixings shall comply with Local Authority requirements. All weldings of both ductwork and supports shall comply with BS 2971 (Arc) and BS 2640 (Gas).

KITCHEN EXTRACT SYSTEMS

All ductwork shall be to constructed to Class “A” specification and tested to Class “B” requirements and be at least one size increase in metal thickness above the standard requirement. Access doors for cleaning with grease tight gaskets shall be installed at every bend or connection and at every 4m on straight lengths of ductwork. All joints to be grease tight. Horizontal ductwork to be installed to fall.

Particular requirements by the Building Control Officer for fully welded ductwork, fire cladding or minimum metal thickness, where applicable, will be specified elsewhere in **Part 3** of this specification.

The Contractor, however, shall comply with the requirements of the Building Control Officer in respect to these matters.

2.17 DUCTWORK

TEST HOLES

Shall be:-

13mm dia. and provided before and after each plant component, at all main branches and before all balancing dampers. Each test hole to be sealed (with “top hat” external type grommet) and in accordance with BSRIA 3/89 - C3/2 and CIBSE Commissioning Code Series A, positioned at agreed with the Engineer on the ductwork layout drawings and (if necessary) after the installation of the ductwork.

INSTRUMENT CONNECTIONS

Shall be:

Provided at all positions shown on the contract drawings, suitably drilled or bossed and screwed to sizes given.

AIR INTAKES & OUTLETS

Fixed louvres on external walls at air intake and outlet positions will be provided and fixed under other aspects of the works unless specified otherwise in **Part 3**. A galvanised steel wire mesh screen of 20mm diamond mesh and at least 2mm dia. wire and complete with a frame of galvanised steel rod with securing lugs or flat iron shall be provided and fixed by the Contractor on the inner side of the louvres, unless otherwise indicated.

Unless otherwise described, the louvres will be surrounded by a timber frame to which ductwork having a galvanised mild steel flange termination will be fixed. The Contractor is to ensure adequate framing is provided by reference to it in his builderswork requirements and drawings.

PLASTIC DUCTWORK

General

All plastic ductwork and associated materials shall be generally manufactured, installed and tested in accordance with “HVCA Specification DW 151 for Plastic Ductwork” but must conform to the standard approved practices as defined below and also to **Part 3** of this specification and the drawings.

The materials shall be suitable for the duty, temperature, chemical and physical conditions prevailing.

Ductwork shall have a smooth obstruction-free interior and wherever possible be circular in cross-section. The ductwork, fittings, thickness of material, stiffeners, jointing and construction shall be suitable for the working pressures, either positive or negative, to be maintained in the systems specified in **Part 3**.

Handling & Transport

Plastic ductwork is more vulnerable to damage than steel ductwork, and great care shall be taken to prevent damage during transport, installation and insitu. It should be remembered that the material is brittle at low temperatures, and appropriate precautions must be taken.

During transportation, soft packing should be used to prevent the transmission of vibration during transporting to site. Broad supports and separators should be used to avoid concentration of load, with increased risk of deformation or cracking, and bouncing should be prevented by use of secure lashings.

Wherever possible, lifting and loading shall be carried out by hand in preference to mechanical handling.

Should open vehicles be used to transport materials, tarpaulin covers shall be used to prevent lifting and wind stresses and to give some insulation against the embrittlement caused by low temperature.

Storage

Ductwork shall be stored under cover, wherever possible. If stored outside for prolonged periods, precautions should be taken against damage from wind and frost. Ducts of large cross-sections should be stored vertically to prevent deformation.

2.17 DUCTWORK

Drainage Points

Drainage points shall be provided at all low points in extract systems.

Materials

General

The materials shall be suitable for the specific application and shall be either unplasticised polyvinyl chloride (UPVC) or fire retardant polypropylene PPS as defined in **Part 3** or any further material defined in **Part 3** of this specification. PPS shall be used in particular for high solvent applications.

This specification also covers the reinforcement of UPVC and PPS ductwork, where size or usage necessitates additional structural strength, by the application of glass fibre/resin laminate (GRP).

Properties of UPVC & PPS

The properties of UPVC and PPS shall be to standards defined below:-

UPVC Materials

UPVC (Unplasticised Polyvinyl Chloride) "Rigid" - materials used shall all be compatible and UV stable with pigment colour to RAL 7011.

- **UPVC "V" Series Tubes & Fittings**

Shall be standard range of 110mm to 1000mm dia. for tubing and 110mm to 600mm dia. for fittings to DIN 8062 for dimension tolerances and of a low flammability and self-extinguishing grade. The fire tests on the materials shall be compatible to BS 476:Part 7:Class 1.

- **UPVC Extruded/Pressed Sheet**

Shall be from the standard range of 1.5mm to 12mm thick, 2400 x 1220 and 3000 x 1500 sheet sizes, manufactured to DIN 7748 and of a low flammability and self-extinguishing grade. The fire test shall be compatible to BS 476:Part 7 and DIN 4802B1.

UPVC sheet to comply with the following standards set out in Tables 1 and 2 below to suit the particular application (unless specified in particular otherwise on the drawings or in **Part 3**).

Table 1 - UPVC Pressed Sheet		
Type	Application	Surface
A1	General Purpose	Glossy
A2	General Purpose	Scratched Plate Only

Table 2 - UPVC Extruded Sheet		
Type	Application	Surface
C1	General Purpose	Glossy
C2	General Purpose	Scratched Plate only

2.17 DUCTWORK

A1 & C1 For use generally within laboratories where visible and high surface cleanliness required.

A2 & C2 For commercial and general chemical and other extract systems as specified.

PPS Materials

- **PPS Tube & Fittings**

Tubes and fittings shall be standard range of 110mm to 630mm dia. for tubing and 100mm to 400mm for moulded fittings to DIN 53479 for dimension tolerances. Colour RAL 7037 and UNI 8318-8536 and shall be low flammability and self-extinguishing grades. Fire tested in accordance with DIN 4102:Part B and UNI 303/3 and also conforming to BS 476:Part 7:Class 4.

- **PPS Sheet**

Shall be from the standard range of 3mm to 12mm thick 2440 x 1220 and 3000 and 1500 sheet sizes. Colour to RAL 7037 and shall be low flammability and self-extinguishing grade. Fire tested in accordance with DIN 4102:Part B and also conforming to BS 476:Part 7:Class 4.

GRP & Laminates

Polyester Fabric & Polypropylene Laminate

This shall be as manufactured by “Celmar” (unless otherwise specified in **Part 3**) and shall be of the standard range of 3mm to 8mm thickness 2440 x 1220 and 3000 x 1500 sheet sizes or the 3mm and 4mm thick, 30m x 1500 wide rolls, as suitable for the application.

The laminate shall be externally reinforced with GRP as defined later in this Specification.

UPVC/GRP

This form of composite laminate shall be used, where defined on drawings or in **Part 3**, on ductwork where it is exposed to possible damage and external installations. The reinforcing method is detailed later in this specification.

UPVC/Foam/GRP or Celmar/Foam/GRP

This type of composite laminate is to be used (where specified in **Part 3** or on the drawings) where internal insulation and/or support is required for chilled air, warm air, heat recovery ductwork systems or similar applications.

CONSTRUCTION METHODS

Duct Sizes & Material Thickness

Tables 3 and 4 (below) give the minimum constructional requirements for both UPVC and PPS rectangular and circular ducts and shall be used in determining material, thickness, stiffener requirement, maximum length and type of joint relative to duct size, unless otherwise specified or there is a requirement for strength in a particular situation, pressure or the particular application requires a greater thickness or greater stiffening.

2.17 DUCTWORK

The fittings used must be of like performance.

Table 3 - Rectangular				
Duct Size (mm)	Material Thickness (mm)	Intermediate Stiffeners (mm)	Max. Length (m)	Jointing
Up to 500	3	-	2.4	Spigot & Socket
Up to 600	3	30 x 6 external	2.4	Spigot & Socket
Up to 900	4.5	30 x 9 external	2.4	Spigot & Socket or Flanged
Up to 1200	6.0	50mm tubes int. fitted	2.4	Flanged

Table 4 - Circular Standard Extruded Tube				
Duct Size (mm)	Material Thickness (mm)	Intermediate Stiffeners (mm)	Max. Length (m)	Jointing
400	3		6	Spigot & Socket
500	4		6	Spigot & Socket
Up to 1200	5		6	Flanged

Rectangular and circular ducting over 1200mm shall be GRP reinforced.

Longitudinal Seams

Longitudinal seams shall not be located at corners or in the bottom face of a rectangular duct or in the lower half of a circular duct.

JOINTING

General

Unless otherwise specified in **Part 3** or on the drawings, fully welded joints shall be used throughout prefabrication and for on site welded jointing. **Only** where specifically specified may PVC adhesive be used and this shall be on socket joints **only**.

Welding

Welders shall be fully competent in all of the materials described herein and welding tests shall be issued under Lloyds certification. The Installer shall include in his costs for cutting away a percentage of welds for the inspection by the Engineer.

Spigot & Socket Joints

Spigot and socket joints shall be formed by purpose manufactured double socket pieces 100mm long and of the same thickness materials as the duct. They shall be welded into position on each standard length of ducting, forming 50mm deep sockets prepared and ready for final jointing on site during erection with PVC adhesive and/or filler rod of the same formulation used for prefabrication work or PVC adhesive **only** if specified in **Part 3**. No exposed metal to be mounted within ductwork.

2.17 DUCTWORK

Flanged Joints

Flanged joints shall be cut from 6, 9 or 12mm sheets x 50mm wide of matching formulation to the duct, depending on its size and operating pressure, and welded to the duct face and back with bolt drillings so placed to permit clearance to the external casing and reinforcing of the ductwork.

Generally, unless otherwise specified in **Part 3**, bright zinc plated nuts, bolts and washers shall be used. These shall be 6 or 8mm, dependent on the duct size, and spaced at maximum 80mm pitch.

Gaskets shall be fitted or non-setting mastic strip for the less corrosive conditions. Where specified in **Part 3** for corrosive conditions stainless steel nuts, bolts and washers should be used with gaskets suitable for the particular corrosive conditions.

Bolts shall be tightened **only** with the use of a torque spanner.

Gaskets

Gaskets shall be made from material suitable for the particular environment and shall generally be of natural synthetic rubber or plasticised PVC except where the environment dictates a special requirement or if specified in **Part 3**.

Gaskets should be 3mm thick for ducts up to 600mm dia. or longer side, and 4.5mm for ducts over this size.

A gasket of unsintered PTFE cord laid in a continuous path along the joint face may be used as an alternative if specified in **Part 3**.

FITTINGS & COMPONENTS

Change Section Pieces

Taper pieces or reducers shall be formed from sheet concentric or eccentric as detailed on drawings, having an angle or taper of 15° maximum with welded joints to ducting at larger end and having loose sockets at the smaller end. Where steeper angles are necessary due to site restrictions, guide vanes shall be provided. Taper pieces, reducers and transformation pieces shall be manufactured from the thickness of material specified for the larger duct size. Transformation pieces from circular to square or rectangular change shall be made such that the angle shall be not more than 15° on any side.

Bends & Splitters

Unless otherwise specified in **Part 3** or shown on the drawings, bends in the rectangular or square ducting shall have a throat radius equal to the length of the side of the duct, forming the side of the bend.

Where this is not practical, bends shall be supplied having a throat radius of one fifth of the width of the duct and the bend shall be fitted with guide splitters.

Branches

Unless otherwise specified in **Part 3** or shown on the drawings, branches and breeches pieces shall be of the radius pattern, the radius to the throat of the branch being not less than half the duct width and shall be formed in the same manner as the bends, neatly welded to the main duct which shall be cut and trimmed to receive same.

Weathering Aprons

Duct penetrations through roofs or external walls shall be provided with weathering aprons, manufactured from 4.5mm thick rigid PVC, externally reinforced with 2 x 450gms/m² GRP, unless otherwise specified, which shall be bedded down on foam strip and secured to builderswork upstands with rawl bolts and dowty seals.

Expansion Joints

2.17 DUCTWORK

Expansion joints shall be provided where necessary to prevent damage or distortion to the ductwork or components when in operation in their normal ambient conditions.

Expansion joints shall be provided in accordance with “HVCA Specification - DW151 for Plastic Ductwork”.

Flexible Connections - UPVC & PPS

Flexible connections shall be provided to form an anti-vibration break between plant and ductwork in locations shown on the drawings.

Synthetic rubber or plasticised PVC, reinforced with cloth as necessary, shall be used for the flexible connections. The material shall be suitable for the conditions.

The type used shall suit the particular application and may be one of the following:-

Fig. A shows the use of band clips for securing the sleeve and is applicable to circular ducts only.

Figs. B and C show the use of a specially moulded connection to be used with rectangular ducts, and where band clips are unsuitable for the application also on circular ducts.

Fig. D shows the alternative method (applicable with UPVC only) of securing a PVC sleeve by welding and is suitable for all sizes of rectangular and circular ducts.

HANGERS, SUPPORTS & BRACKETS

Normally, mild steel sections will be used in sizes to meet the total loading and with the standard of protective finish suitable for the environment. The accepted methods of supporting and bracketing mild steel ductwork apply also to plastics ductwork, but the greater linear expansion of the latter must be taken into account when positioning supports and brackets.

Horizontal Ducts

MS hangers and supports recommended for horizontal ducts are given in Table 6.

Vertical Ducts

Supports for vertical ducts shall be designed and fabricated by the Installer to suit site conditions, and spacings may be greater than for horizontal ducts. Ducts shall be supported at the stiffening angles or the angle flanges, but where this is impracticable, supporting angles shall be fixed to the duct.

External Ducts

Where ducts are external to buildings and may be subject to wind loading, the necessary supports shall be placed so as to restrain side thrust and to allow axial movement as necessary.

All external ductwork shall be GRP wrapped to a colour when specified in **Part 3**.

Expansion Joint Supports

Supports, designed to permit axial movement only, shall be provided on either side of expansion joints.

2.17 DUCTWORK

Anchors

Anchoring points shall, for maximum strength, be at the stiffening angles or angle flanges of ducts.

Table 6 - Hangers & Supports for Horizontal Ducts					
Duct Width or Dia.	Hanger Section		Rectangular Ducts - Min. MS Bearing Member	Circular Ducts - Min. MS Clip Section	Max. Spacing
	MS Rod Dia.	MS Flat			
1	2	3	4	5	6
(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
Upto 450	6	25 x 3	30 x 30 x 4	25 x 3	2400
451 to 800	8	30 x 5	40 x 40 x 4	40 x 5	2400
801 to 1200	10	40 x 5	50 x 50 x 6	50 x 5	2400

DAMPERS

System Dampers

Dampers shall be fitted in main and branch ducts where shown. These shall consist of an Aerofoil damper blade, manufactured from 4.5mm or 6mm dependent on the cross-section of the ducting. Ducts greater than 300mm wide (on the short side) shall have multi-leaf dampers so that no blade is greater than 150mm wide including allowance for overlap. The material for the Aerofoil damper blade shall be rigid PVC unless otherwise specified.

Rigid PVC shafts shall be used mounted within PTFE bearing and PVC casing blocks welded to the main ducting. The damper blades shall be mounted onto the PVC shafts and secured with stainless steel nuts and bolts. One end of the PVC shaft shall be capped off with a rigid PVC cover welded to the ductwork, the other end shall be fitted with indicator plate showing open and shut position.

Pressure Relief Dampers

These shall be of the balanced blade type for pressure relief flaps, with fine adjustment of relief pressure settings and with a seal as airtight as practicable when closed.

FIRE DAMPERS & FIRE & SMOKE DAMPERS

General

Fire and fire/smoke dampers, where called for, shall be of the type specified in **Part 3** and located where shown on the drawings.

Fire dampers should be avoided on fume and toxic extract systems and should be installed only when specifically specified.

Fire and fire/smoke dampers shall be supplied and fixed with installation mounting frames which conform to the prevailing Building Regulations and be acceptable to the District Surveyor, Building Control Officer and Fire Officer, in accordance with BS/142 Fig. Nos. 164 and 165.

2.17 DUCTWORK

The construction shall allow for all additional framing supports and bracing as may be necessary to adequately attach the fire dampers to the structure. The assembly to be approved by the District Surveyor, Building Control Officer and Fire Officer.

Each fire damper and installation mounting frame shall have at least the same standard of fire resistance as the wall or floor through which the duct passes, unless otherwise indicated it shall have a minimum fire resistance rate of 2 hours to the dynamic heated gas flow tests of EN1366-2 Classification ES and to BS 476:Part 8/20. When a fire resistance rating of 4 hours is required either 2 No. dampers factory assembled in series or a single damper having a fire resistance rating of 4 hours certified by an approved Testing Authority shall be provided.

The Ductwork Sub-Contractor shall obtain and issue proof of the necessary approvals of the fire dampers to the Contractor.

The Contractor shall be responsible for ensuring the inspection and testing of all fire dampers installed on the contract is carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the Manufacturer's data sheets.

Access panels with chains shall be provided adjacent to the access side of all fire dampers.

In no instances shall flexible duct connections be allowed on to fire dampers or through floors and walls.

Fire Dampers - Stainless Steel Curtain Pattern

All fire dampers shall be provided with the shutter blades located outside the airstream (unless otherwise specified). Dampers and installation mounting frames to be manufactured in all stainless steel, grade of which to be suitable for contaminants as specified in **Part 3** of the specification. Each damper shall have a stainless steel curtain in an all welded stainless steel casing with stainless steel side seal gaskets. The damper blade curtain shall be held in the folded position by a dual safe thermal actuator and fusible link.

All damper blades shall be tensioned to ensure instantaneous closure on thermal activation at 72°C unless specified elsewhere. A self-latching reset mechanism shall be provided for each re-setting of the damper curtain.

Combination Smoke/Fire Dampers

All smoke/fire dampers and installation mounting frames to be manufactured in all stainless steel, grade of which to be suitable for contaminants as specified in **Part 3** of the specification, shall be of the multi-blade type with interlocking stainless steel Aerofoil blades which shall be held in the open position by an electrical power supply and thermal sensor incorporated within the control mode.

Upon activation of the thermal sensor at 72°C, unless specified elsewhere, or removal of the power supply to the damper control mode, the damper blades shall instantaneously close and interlock to provide tight smoke sealing and fire control.

All dampers shall be remotely resettable by restoration of the power supply unless the thermal sensor has been activated. Each damper control mode shall have interface facilities to operate as commanded by a dedicated fire/smoke control panel within the building. Power supply shall be 24V ac or 220/240V ac as specified in **Part 3**.

Intumescent Dampers

Intumescent dampers shall be supplied and installed in locations indicated on the drawings.

The complete installation shall meet the requirements of the District Surveyor, Building Control Officer and Fire Officer.

“Pipecrush” Fire Damper (Quelfire or equal)

2.17 DUCTWORK

“Pipecrush” fire dampers shall be supplied and installed in locations as indicated on the drawings and **Part 3** of the Specification.

The complete installation shall meet the requirements of the District Surveyor, Building Control Officer and Fire Officer.

ACCESS OPENINGS

General

All access openings shall be installed where shown on the drawings and shall be rigidly framed, with airtight covers designed to facilitate removal and replacement.

Access Covers

Subject to the restriction of duct size, access openings shall not be smaller than 375mm x 300mm or larger than 450mm x 375mm, unless specifically indicated on the drawings.

Removable access covers shall be located adjacent to all plant and equipment requiring periodic inspection, servicing or replacement such as regulating dampers, fire dampers, air filters, for cleaning access and where shown on drawings or further specified in **Part 3**.

Hinged access doors shall not be used because of the difficulty of sealing and the risk of over stressing hinge attachments.

Test Holes for Commissioning

Test holes of 25mm dia. and fitted with an effective re-usable seal shall be provided as standard in location shown on the drawings.

Other Openings

The location and size of any openings required other than the above, shall be as specified in **Part 3** or as shown on the drawings.

REINFORCEMENT OF DUCTS WITH GRP LAMINATE

Requirement

Where ductwork is required in larger sizes than are covered in Tables 3 and 4, or with increased strength requirements, reinforcement shall be provided by the application of glass fibre or glass fibre/resin laminate (or when specified for other sizes).

GRP laminate may be used with standard UPVC sheet, but for PPS specially prepared sheet with a glass fabric backing incorporated during manufacture, (CELMAR) shall be used.

Materials

Quality

The GRP laminate shall be made up of polyester resin complying with the requirements of BS 3532 and glass fibre complying with the requirements of BS 3496 or BS 3497. The nominal ratio of resin to glass fibre shall be 70:30 by weight.

Minimum Properties

2.17 DUCTWORK

The laminate shall comply with the following minimum physical properties:-

Tensile Strength - 70 MN/m²

Tensile Modulus - 7 GN/m²

Flexural Strength - 140 MN/m²

Bond Strength (between laminate & substrate) - Not less than 7 MN/m²

Barcol Hardness - Not less than Manufacturer's specification

PPS with Glass Fibre Backing incorporated during Manufacture

The technical manuals issued by the Manufacturers shall be consulted for the fabrication of ductwork from proprietary PPS sheet reinforced with GRP. The use of PPS with glass fabric backing shall involve some modification to fabricating procedures to ensure that shaping and forming processes do not press the glass fabric so deeply into the PPS that its function as a key is lost and that all glass particles are eliminated before and welding process is carried out.

UPVC & PPS Reinforced Ductwork

Where cutting of GRP reinforced ductwork is necessary, it shall be carried out by reciprocating jigsaw or by orbital saw. For forming holes larger than 12.5mm dia., the use of a hole saw is recommended in preference to a drill.

Where welding of reinforced ductwork is necessary, the weld shall be made on the parent material. Thus, laminate to the same thickness and standards of workmanship as specified above shall then be applied. The new laminate shall overlap the existing by at least 75mm.

Finishes - Colour

Shall be the natural colour of GRP "Straw Green" unless specified otherwise in **Part 3**.

Workshop Conditions

As polyester resins are sensitive to temperature, the workshop where fabrication takes place shall be maintained at a temperature of between 20°C and 25°C and high relative humidities and damp conditions should be avoided. A good rate of air change should be provided by mechanical ventilation in the workshop.

Storage of Materials

Resin and curing agents shall be stored in dark, cool conditions, away from the working area, and in conformity with Statutory requirements for the storage of flammable liquids.

Because of the limited storage life of the **unmixed** resin and curing agents, materials shall be checked before use to ensure that they are within the Manufacturer's specified shelf-life.

Glass fibre shall be stored separately under dry conditions.

Surface Preparation

UPVC

To achieve the specified bond strength, the surface to which the GRP is applied shall first be thoroughly cleaned and then etched, either by mechanical means or by the use of a suitable solvent.

PPS With Glass Fibre Backing

To achieve the specified bond strength, the fabric backing shall be thoroughly impregnated with resin.

Mixing the Material for Use

2.17 DUCTWORK

The resin is a 3-part mix - comprising base resin, hardener and accelerator. The Manufacturer's instructions for mixing the handling **MUST** be meticulously followed. The specified proportions of base resin, hardener and accelerator **are critical**, and the mixing sequence specified by the Manufacturer **must** be followed meticulously.

The **mixed** material has a **very limited effective life after mixing**, depending on factors such as the characteristics and bulk of the resin, the amount of hardener, the degree and method of acceleration, and the workshop conditions.

Therefore, **no more material should be mixed at one time than can conveniently be applied within the pot life of the mixed batch.**

Methods of Application

The mixed resin may be applied either by hand or by spray deposition. With either method, the operation must be completed within the gel time of the system and the laminate fully consolidated, to achieve the physical properties specified.

Construction Methods for GRP Reinforced Ductwork

General

Minimum constructional recommendations are given in Table 5 for rectangular and circular ductwork where GRP reinforced ductwork is provided.

All ductwork rectangular or circular over 1200mm shall be GRP reinforced.

2.17 DUCTWORK

Below 1200mm it shall be reinforced where necessary to give additional strength where circumstances require.

TABLE 5					
Minimum Requirements					
Rectangular & Circular GRP Reinforced Ducts					
Length of longest side of rectangular duct or max. dia. of circular duct	Minimum sheet thickness & reinforcement		Suitable cross joint	Suitable intermediate stiffener	Maximum spacing between joint stiffener
1 (mm)	UPVC 2 (mm)	PPS 3 (mm)	UPVC & PPS 4 (mm)	UPVC & PPS 5 (mm)	UPVC & PPS 6 (mm)
Up to 400	3+0.6kg/m ² GRP	3+0.6kg/m ² GRP	50 x 6 flat backed by 1.2kg/m ² GRP 8mm bolts upto 80mm centres	50 x 6 flat backed by 1.2kg/m ² or GRP 40 x 40 square section backed GRP	1200
401 to 900	4.5+0.9kg/m ² GRP	4.5+0.9kg/m ² GRP	50 x 6 flat backed by 1.2kg/m ² GRP 8mm bolts upto 80mm centres	50 x 6 flat backed by 1.2kg/m ² or GRP 40 x 40 square section backed GRP	1200
901 to 1200	4.5+1.2kg/m ² GRP	4.5+1.2kg/m ² GRP	50 x 6 flat backed by 1.2kg/m ² GRP 8mm bolts upto 80mm centres	50 x 6 flat backed by 1.2kg/m ² or GRP 40 x 40 square section backed GRP	1200
1201 to 2250	6+1.2kg/m ² GRP	6+1.2kg/m ² GRP	60 x 6 flat backed by 1.8kg/m ² GRP 8mm bolts upto 80mm centres	60 x 6 flat backed by 1.8kg/m ² or GRP 40 x 40 square section backed GRP	1200
2251 to 3000	6+1.2kg/m ² GRP	6+1.2kg/m ² GRP	70 x 9 flat backed by 1.8kg/m ² GRP 8mm bolts upto 80mm centres	70 x 9 flat backed by 1.8kg/m ² or GRP 40 x 40 square section backed GRP	800
<ul style="list-style-type: none"> • Rigid foam insulation or other reinforcing may be inserted between first and second lay-ups. • Special fire retardant resins are available, also intumescent emulsion coatings to achieve BS 476:Part 7 Class 1 and Class O in accordance with Building Regulations 1991. 					

2.17 DUCTWORK

TESTING FOR AIRTIGHTNESS

Standard of Air Tightness of Systems

The ductwork shall be constructed and systems shall be installed to withstand the operational pressures within the systems stated in **Part 3** plus a 30% margin on pressure.

On toxic or high risk “gases”, **no leakage** shall be permissible.

Method of Testing Ductwork & System for Leakage

The ductwork and system shall be tested for leaks using a detectable inert gas and electronic leak detector or as defined in **Part 3**. The tests shall be carried out to a method statement prepared by the Contractor and agreed by the Engineer.

DUCTWORK INTERNAL CLEANLINESS

General

Unless otherwise specified, ductwork cleanliness shall be to DW/TM2 basic level. But shall additionally include for the following:-

- All ends of open ductwork shall be closed off during installation.
- Openings in terminal units (ie. fan coil units, VAV units) shall be protected.
- The programme shall allow for the systems to be blown through prior to final connections to terminals, grilles, diffusers etc. are made.
- Wherever it is practical within the working conditions of the site, ductwork should be stored in a dry, dust-free location.

Access Panels for Cleaning

Access panels for cleaning ductwork in accordance with Health & Safety Executive requirements shall be provided where indicated on drawings or specified later in this document.

SERVICE IDENTIFICATION

Colour coding and identification of ductwork to DW/144, shall be carried out by the Contractor in conjunction with the Ductwork Installer incorporating basic identification triangle and name of system.

Additional hazard symbols to BS 3510 and BS 5378 on extract systems carry radio-active, infectious, toxic, chemical or explosive substances shall be as specified within **Part 3**.

Service identification of insulated ductwork will be carried out by the Contractor.

All fire, control, regulation dampers shall be identified on their respective ductwork and at a visible position on the building fabric if the ductwork is concealed.

Each grille, diffuser and relief flap (and their settings) to be uniquely identified together with their locations. This work will require liaison with the Ductwork and Commissioning Contractors.

The Contractor shall supply and fix colour coded identification buttons to ceiling tiles where any damper on a duct run is above a suspended ceiling.

Each primary control damper shall be fitted with a non-corrodible label stating the actual air flow in, m³/s and the cross-sectional area. Alternatively, these figures shall be painted in a visible position on the adjoining

2.17 DUCTWORK

ductwork or insulation. The position of a damper as set after final regulation and balancing shall be indelibly marked on the damper quadrant.

SUMMARY OF MAIN VENTILATION REQUIREMENTS

Before commencement of work the specialist ductwork contractor is to submit shop drawings, indicating grille supports, fire dampers access doors (with sizes)

All 90 degree bends, which are shown to be of square construction, are to have double deflection air turns (Barber Coleman) across the full face.

Volume control damper blades to be of double skin construction.

Volume control damper to be multi-blade type (above 300mm longest side)

A mezz flange system is to be used on rectangular ductwork (above 300mm longest side) where space allows.

All joints are to be sealed with an appropriate sealant and taped in accordance with DW144.

Ducts are to be sealed internally when and where possible.

Minimum thickness of galvanised sheet steel is to be 22 SWG (except for grille boxes)

Brackets and fixing are to be generally in accordance with DW144. Studding – threaded rod to be plated and a minimum of 8mm dia.

Access door panels are to be provided adjacent to fire dampers, volume control dampers and in accordance with DW144.

The insides of grille boxes and in-view internal ductwork, is to be sprayed with matt black paint.

Flexible ductwork is not to be used, for changes in direction of circular galvanised ductwork.

Flexible ductwork when used for final connections will be secured by metal fasteners (Not cable ties). The maximum length of flexible ductwork for final connections is 0.5M.

Plastic ductwork is to be installed in accordance with DW151

Fire dampers are to be fitted where fire compartmentation zones have been specified.

The Ventilation Systems, once operational are to be balanced, to meet the performance figures listed in the Schedules and drawings. A full set of commissioning results excluding fan performances is to be given to the CA for inspection before insertion into the O & M Manuals.

A complete set of new spare filters, are to be provided at time of handover, to the CA. They are to be carefully packed for storage and labelled for respective plant and filter types.

2.18 PIPEWORK

STANDARDS OF INSTALLATION

The installation of piped services shall generally be as indicated on the drawings and suitable for the particular service or application involved. Pipework shall be neatly arranged and adequately spaced to facilitate the insulation process as appropriate and permit access to valves or other component as may be necessary to operate or maintain the installation. Pipework shall follow the contours of walls and the clearance between pipework (or the lagging) and the wall and any other fixtures shall be no less than 50mm.

Tubes shall be reamed after cutting and shall be free from burrs, rust, scale and other defects and shall be thoroughly cleaned before erection.

Open ends of pipework and fittings shall be protected during transport, storage and the installation process to prevent the ingress of debris using components specifically available for that purpose.

Pipework shall be adequately supported on suitable hangers, brackets or rollers according to position, location and type, with attention given to accommodate movement due to expansion and contraction. Movement shall be proportioned throughout the system by the provision of anchors and guides. Expansion loops shall be used wherever practical where it is necessary to reduce stresses.

Dependent upon the type of pipework being installed and its location, anchoring and restraining devices shall be fitted to secure pipe and fittings against thrust at bends, tees etc.

All pipework shall be installed with continuous gradients to allow drainage and for the release of air according to type of service. Air vents of the appropriate type shall be fitted to all high points where this cannot be achieved via open vent pipework or appliance terminal fitting.

Where it is necessary for manual air vents to be provided, they shall be fitted at the highest points of the sections which they are intended to vent. Air bottles shall be made from 50mm size tube each approximately 300mm long fitted with a cap and 8mm size air cock; they shall be fitted to equal tees or have 50mm connections if the main is 50mm size or above.

Where an air bottle is fixed out of reach, a 15mm size extension tube shall be run from the cap to within 1.5m of the floor, terminating with a 15mm size needle-seated key operated air lock.

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

Automatic air vents shall be used **only** where indicated. They shall have gunmetal or brass bodies, non-ferrous or stainless steel floats and guides, and non-corrodible valves and seats. Each automatic air vent shall be controlled by a lock shield valve which should be an integral part of the air vent body. Air release pipes shall be run to discharge at the nearest suitable visible point.

Drainage provisions shall be provided at all low points of the installation, and where required for use as flushing points. These shall be of a size commensurate with the flow capacity of the pipework served and of the full way straight through pattern incorporating a secure plugged end for when not in use. Flushing points shall be a minimum of 50mm or the size of the pipe if smaller than 50mm.

Pipes passing through external walls, floors and roofs shall be installed with puddle flanges or sleeves as appropriate, sealed against water, gas, vermin, dust and spread of fire with an agreed material that complies with Local Authority Building and Fire Regulations.

Where passing through walls and floors, copper, mild steel and plastic pipework shall be sleeved and fire stopped. Where exposed in finished or occupied areas, masking plates shall be fitted and fastened securely to the pipe. The sleeve shall be the same material as the pipe.

Installation of gas services and unvented domestic hot water service installations shall be carried out by companies registers with the appropriate registering body using identifiable competent employees on installation work.

2.18 PIPEWORK

On completion or sectional completion as may be appropriate, the respective systems installed shall be checked for completeness and flushed to remove any accumulation of scale, or debris occurring during the installation process and to establish that pipework, fittings and waterways in plant items are clear and free of obstruction.

The application of insulation or protective wrapping of tubes and fittings shall not be carried out until after satisfactory pressure, welding or any other testing of the service involved has been completed.

All pipework, valves and fittings shall be supplied with Manufacturer's standard finish or protective coating.

All fabricated steelwork and steel pipework other than galvanised to be thoroughly cleaned of all scale, corrosion, grease etc., after erection and painted with corrosion resistant paint or coating suitable for service conditions or as specified in **Part 3**.

All services to be identified and labelled and notices shall be provided.

All valves to have labels attached to identify service, valve function, valve reference number and size.

Notices, labels and other methods of identification shall be as defined in Parts 2 and 3 of this specification.

Valve charts shall be provided for all piped services.

Heating pipe work is to be installed in heavy weight, mild steel tube (BS 1387). Malleable swept fittings are to be used wherever practical.

PIPEWORK JOINTS & FITTINGS

Low Temperature Hot Water, Medium Temperature Hot Water, Condenser Water, Chilled Water, Steam & Condensate

Joints on all permanently concealed pipework and all pipework 65mm size and above shall be welded. All other pipework shall have screwed joints with threads to BS 21 with tapers on pipes and adaptors.

Mechanical grooved joints may be used for LTHW and chilled water where specified in **Part 3** and as defined later in Part 2.

On screwed joints at least one of the two engaging components shall be taper threaded and the jointing between them shall be made with an approved HVCA jointing material. Screwed fittings shall be manufactured by BS 143.

At dismantling points or where the pipework is connected to an appliance, ground on spherical seated unions shall be used for pipework up to 50mm size and flanges shall be used for pipework 65mm and above, unless grooved mechanical joints are specified.

Flanges shall be BS 4504, rated to match the pressure of system but to be rated at not less than 16 bar. Joints shall be made with gaskets suitable for the pressure and temperature and extending to the inside of the bolt circles.

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

Mild steel headers shall be of flanged construction with flanged outlets welded on and spare outlets shall be blanked off with bolted flanges. Where grooved mechanical joints are specified, grooved mechanical blank ends may be used.

Pipe joints which will unavoidably be built over or otherwise be difficult to access to be of the welded, or capillary type only, and satisfactorily tested before concealment.

Where any services comprises more than one type of tube or pipe and conversions are necessary in the connection between one tube or pipe type and another, or where such tubes or pipes connect to differently

2.18 PIPEWORK

dimensioned plant or equipment, the Pipework Installer shall be responsible for providing and installing the necessary adaptors.

All fittings shall, as far as practicable, be the same size as the tubes and pipes connected to them. Bushed outlets will only be accepted if the required outlet size of a fitting is not of standard manufacture.

Pipe fittings shall be low resistance type bends, sweep tees etc.

Elbows or bends may be used but square elbows will not be permitted, except on final draw-off pipe runs and, if necessary, to facilitate venting and draining, or at steam trap sets for venting, draining or relaying.

Eccentric reducing sockets shall be used where change of bore are made in runs of nominally horizontal pipework to facilitate air venting and draining.

Suitable sets of springs may be used where it is necessary to deviate from a straight run in ungalvanised pipework. In galvanised pipework, deviations shall be formed from standard fittings.

Joints shall not be made in the thickness of any wall, floor or ceiling and pipework shall not be embedded in the structure of floors unless particularly specified or indicated on the drawings.

MECHANICAL GROOVED JOINTS ON CARBON STEEL PIPEWORK

General

Mechanical grooved joints shall be used where specified in **Part 3** on carbon steel pipework, in lieu of unions, welded, flanged or screwed pipe connections, (except where the water temperature exceeds 110°C).

Mechanical grooved joints must not be used at water temperatures of more than 110°C.

They shall only be used on carbon steel pipe that has been grooved in accordance with the Joint Manufacturer's specifications and shall be self-centering and engage and lock in place the grooved pipe and/or pipe fitting ends to form a positive watertight assembly whether used with the rigid or flexible pattern of joint, specified in **Part 3** or on the drawings.

The mechanical grooved joints shall be manufactured in malleable cast iron to BS 6681, ductile iron to BS 2789 or carbon steel to BS EN 10 025 GRADE Fe 430A and consist of two or more segments which enclose and control a synthetic elastomeric gasket, so designed that the integral water pressure increased the watertightness of the seal. The coupling assembly shall be securely held together by two or more trackhead, square, D-shape or oval-neck carbon steel bolts and nuts in accordance with the Manufacturer's specification. All pipe fittings connected to mechanical pipe joints shall have the ends grooved to suit the joint dimensions and fully comply with the Joint Manufacturer's specifications.

The use of the flexible mechanical grooved joints or rigid mechanical grooved joints will be defined in **Part 3** of this specification and on the drawings.

Pipe & Pipe End Preparation

The pipe ends shall utilise the mechanical pipe joints manufactured from carbon steel and comply with BS 1387, BS 3601 or other recognised standard that is fully compatible with the mechanical joints. Pipe ends shall be either cut or roll-grooved using appropriate machined approved by the Mechanical Joint Manufacturer to provide a rectangular groove in the outside surface of the pipe end to meet in every respect the Joint Manufacturer's dimensional requirements.

The method of grooving shall take full recognition of the pipe wall thickness, diameter and service conditions.

The Installer shall obtain such training from the Grooving Machine Manufacturer or Supplier as necessary to ensure the full familiarity of Personnel with the grooving equipment and procedures.

2.18 PIPEWORK

Pressure Rating & Testing

Pressure rating mechanical joints shall be not less than 1½ times the continuous maximum working pressure rating of the system. The system is to be pressure tested without leakage prior to commissioning at a pressure of up to 50% higher than the continuous operating pressure of the system, but not less than 7 bar.

Gaskets

Mechanical joints shall be provided with elastomeric gaskets by the Joint Manufacturer made from synthetic rubber which meets the requirements of BS 2494:1990, Type W for cold potable water, Type H for hot water, as appropriate, according to the temperature rating of the system. These gaskets to be as listed by the United Kingdom Water Fittings Bye-Laws Scheme (UKWFBS).

Gaskets for use on oil or hydrocarbon fuel systems shall be fitted with gaskets meeting the requirements of BS 2494:1990, Type G.

Pressure responsive gaskets **shall not** be used on natural or manufactured gas systems or on other flammable or toxic gas systems.

NOTE:

Rubber gaskets shall not be disposed of by burning as harmful by-products can be produced. The gaskets shall be stored before use in a cool, dark place, free from strain in order to maintain a maximum operational life and performance. They shall not be hung for storage or twisted in any way and any joints so found will be rejected. The rings shall not be subjected to direct sunlight or ozone as this will cause damage.

Manufacturing Requirements

All mechanical joints for grooved steel pipe shall be manufactured by a company operating a recognised quality assurance scheme in accordance with BS EN ISO 9001:1994, and additionally be covered by a current certificate of the British Board of Agreement.

Installation & Training

All mechanical joints on grooved steel pipes to be installed in accordance with the Manufacturer's instructions.

Support spacings shall be as for conventional pipework construction, according to pipe diameter, and also meet the minimum requirements of the particular Manufacturer of the mechanical jointing system specified. Externally applied loads shall be considered separately in calculating support centres.

When flexible mechanical pipe joints are specified in **Part 3**, the pipes **shall not** be supported in the central third of any pipe length and supports shall not be placed closer together than 1/3 of the pipe length nor support the pipe rigidly close to both sides of any joint. Each bend or reducer shall be supported either directly, or to one side of the fitting within 1/3 of the adjacent pipe length. Each tee or cross shall be supported either directly or at least at any two of the immediately adjacent pipes within 1/3 of the pipe length.

Pipework shall be within the Manufacturer's recommended tolerance for linear expansion and angular deflection.

Mechanical pipe joints may be used to cater for pipe expansion - within the Manufacturer's recommendations. Where necessary, mechanical joints may be used in conjunction with expansion bellows as specified in **Part 3** or shown on the drawings.

An approved WRC listed gasket lubricant shall be used in the installation of all mechanical joints to aid seating of the gasket and prevent pinching between the housing sections. This lubricant shall be suitable for use on elastomeric gasket and potable water systems.

2.18 PIPEWORK

All Fitters and other Personnel involved with the installation of the pipework system shall be fully familiar with the operation and installation of the mechanical joints, include training to achieve this. If necessary, the Installer must provide for appropriate training to be given by the Joint Manufacturer to his Staff.

Electrical Continuity

Electrical continuity shall be preserved by mechanical flexible joints being fitted with a properly designed bonding conductor and accessory clips which provide equipotential bonding between adjacent pipes in the system.

TABLE 1 Carbon Steel Pipes - Mechanical Grooved Joints				
Item	Nominal Size	Description	British Standards	Notes
Pipe	20 - 150	Roll grooved	BS 1387:Table 4	Medium
	200 - 600	Roll grooved or Cut grooved	BS 3601	
	20 - 150	Cut grooved	BS 1387:Table 5	Heavy
Mechanical Coupling	20 - 600	Malleable cast iron housing to BS 6681		Flexible joint
	40 - 600	Ductile cast iron housing to BS 6681		Rigid joint
Plain Ended Mechanical Coupling	40 - 400	Malleable cast iron housing to BS 6618		Rigid joint
Grooved in Flanged Adaptor	50 - 300	Ductile iron housing to BS 2789		Rigid joint
Quick Release Mechanical Coupling	50 - 200	Ductile iron housing to BS 2789		Flexible joint
Fittings	25 - 300	Cast fittings malleable iron to BS 6681		
		Fabricated steel fitting to BS 1965:Part 1		
Equal Tees	25 - 400	Cast fittings malleable iron to BS 6681	Makers Standards	
Reducing Tees	50 - 200	Cast fittings malleable iron to BS 6681	Makers Standards	
Mechanical Tee	65 - 200	Grooved, malleable cast iron housing	BS 6681	
	32 - 50	Screwed, malleable cast iron housing	BS 6681	
Groove Ended Butterfly Valve	65 - 200	Ductile iron housing to BS 2789	BS 5155	
Groove Ended Strainer	65 - 200	Ductile iron housing to BS 2789	Makers Standards	
Gaskets	All sizes metric	Elastomeric gaskets made from synthetic rubber supplied by Joint Manufacturer	BS 2494 Type W for cold water, Type H for hot water & Type G for oil	

All fittings to be to Joint Manufacturer's approval.

2.18 PIPEWORK

BURIED PIPEWORK

All cold water pipes shall be buried at a depth of between 1000mm to 1350mm to top of pipe to suit local conditions and requirements against freezing.

In the case of gas services, these shall be buried in accordance with the recommendations of the Institute of Gas Engineers Document IGE/UP/2. Pipework exceeding 50mm dia. shall have not less than 600mm depth of cover under paved footpaths and not less than 750mm depth of cover under roadways and grass verges. Pipework not exceeding 50mm dia. shall have not less than 375mm depth of cover

Protected against possible damage by any future excavation work, shall be by the use of proprietary plastic warning marker tapes. A 150mm wide mesh laid along the pipe run during backfilling and positioned between 150mm and to 225mm below ground level, the tape or mesh to have a stainless steel wire for pipe detection on plastic systems.

The wire shall be connected to a standard electrical earth rod pit valve at each end, as specified in **Part 3**

BURIED PIPEWORK MARKERS

As set out in **Part 3** and on the drawings, buried pipe markers shall be provided at 50m intervals along the specified pipe run on straight sections and at all changes of direction and each side of roadways and shall consist of 200mm x 200mm x 50mm formed of reinforced concrete, bearing non-corrodible and durable plates having permanent letters and numbers stamped or cast on stating:-

- Pipe size in mm eg. 200 and include direction.
- Services eg. CWS arrows where this is necessary.
- Depth of service in mm eg. 900 to indicate pipe run direction.

They shall be secured to raised concrete marker posts in unmade ground and to flush concrete blocks in lawns, verges or pavements or be attached to buildings at the point of entry.

The distance shall be stated from plate to service in the case of services running parallel to buildings.

Markers shall also be located at valve positions and comprise of raised letters cast on the exterior surface of the box cover to indicate type of service, with separate marker plate to indicate the valve function.

WELDED PIPEWORK

Welding as specified elsewhere in this document or on the drawings shall be carried out in accordance with the following Standards and Codes of Practice by Welders holding a valid certificate of competency.

Steel Pipework

All carbon steel pipework shall be welded in accordance with the requirements of the current edition of the Heating & Ventilating Contractors' Association (Technical Document TR/5 "Welding of Carbon Steel Pipework").

Unless otherwise specified in **Part 3** of this document, the carbon steel pipework shall be Class II welded in accordance with the current editions of BS 2971 (arc welding) and BS 2640 (gas welding).

Where Class I welding is specified in **Part 3** of this document, it shall be welded in accordance with the current editions of BS 2633 Class I (arc welding), BS 1821 Class I (gas welding) and BS 4677 Class I (arc welding of austenitic stainless steel).

2.18 PIPEWORK

Steelwork, Tanks & Non-Pressure Vessels

For applications where BS 2654 (vertical steel non-refrigerated storage tanks with butt welded shells), BS 5799:Part 5 (oil storage tanks) or BS 5500 (unfired fusion welded pressure vessels) do not apply, all welding shall be carried out to the current edition of BS 5135.

Steel Diesel Generator/Boiler Flues

Steel diesel generator and/or steel boiler flues shall be welded in accordance with the requirements of:-

- BS 5135, Category C.
- OR
- BS 2971, Class II (arc).

As specified in **Part 3** of this document.

Welding Inspections & Testing

All on and off site weldings shall be subject to inspection and monitoring by a competent qualified Welding Engineer. Accurate records of inspections, welding procedures, test and dates shall be kept by the Welding Engineer.

The execution of welding and the competence of the Welder shall be in accordance with Code of Practice for Welding of Carbon Steel Pipework, Recommended Practice and Tests for Competency 1980 issued by the Heating & Ventilating Contractors' Association (Technical Document TR/5).

The Contractor is to demonstrate the quality of the Welder's work in accordance with BS 4872:Part 1.

When visual tests on completed work indicate that the quality of welding could be below specification then the Contractor may be called upon to have the welds examined by radiography as a test of acceptability, or any other method described in the Code of Practice for Welding of Carbon Steel Pipework 1980 issued by Heating & Ventilating Contractors' Association (Technical Document TR/5).

All welds to be stamped with identification of Welder. 10% of welds to NTD.

Silver Brazing

All silver brazing of copper pipework shall be carried out in accordance with the current edition of the Heating & Ventilating Contractors' Association (Technical Document TR/5).

Capillary Soldered Joints (Copper or Stainless Steel)

Capillary soldered joints shall be to BS 864:1983 AMD 5097 6/86, 5651 4/87, 7067 2/92:Part 2 using integral ring fittings with lead-free solder and marked accordingly, for hot and cold water services and for all other services to standardise on site inspection requirements and made using the correct grade of flux to suit the service requirements.

Capillary Brazed Joints

Capillary brazed joints shall be to BS 1723:1986:Part 1 and BS 1306:1975(1990) AMD 3124 2/80 and in accordance with the recommendations in HVCA Code of Practice TR/3. Made and inspected generally in accordance with procedures as specified for capillary soldered joints and exclude bronze weld.

The correct grade of silver brazing alloy and flux to BS 1845:1984 shall be used to suit the service conditions as indicated on the pipework materials tables and to meet the requirements for potable water quality in the case of hot and cold water services.

The brazing of copper water pipework shall be carried out using a filler rod complying with BS 1845:1984:Type CP1, CP2 or CP4 to suit the circumstances involved. Where copper is to be joined, these rods

2.18 PIPEWORK

may be considered to be self-fluxing, but where copper alloy fittings are to be jointed to copper, the Manufacturer's recommended flux to be used.

Silver brazing shall be carried out on condensate mains assembled from copper tube and heavy duty fittings where a brazing alloy to BS 1845:1984:Type AG14 or AG20 or similar approved filler should be used (the pipe end only being fluxed). The flux to be as recommended by the Manufacturer.

Where brazing of copper to gunmetal/bronze is required, the joints shall be made using a copper-silver-zinc brazing alloy to BS 1845:1984:Type AG14 or AG20 or similar approved filler together with an appropriate flux as recommended by the Manufacturer. The process to be carried out under controlled conditions and in a clean condition suitable for use as appropriate for the service intended, with no traces of flux, grease or other matter on the completed items. Each person producing brazed joints to be provided with a steel marker die with which to mark all completed joints with his identification symbol.

Where applicable and/or specified to be tested in accordance with BS 1723:1986:Part1, HVCA Code of Practice TR/3 and BS 6443:1984.

Costs shall be included for testing of joints during contract.

PIPEWORK SUPPORTS, EXPANSION & ANCHOR POINTS

Pipework shall be adequately supported in such a manner as to permit free movement due to expansion and contraction.

Pipework supports shall be arranged as near as possible to joints and changes in direction. The spacing of the supports shall not exceed the centres given in the tables and text below. Where there are two or more sizes of pipes, the common support spaces shall be based on the centres required by the smallest bore pipework.

Where vertical pipework up to 50mm size is fixed to solid walls, brackets may be of the screw on or long shank built-in type. For fixing to woodwork or lightweight partitions or walls they shall be screw on pattern and may be adjustable two piece type. The upper half of the pipe clip shall be detachable without disturbing the fixing. Cast iron and steel spigot and socket pipework shall be supported at each point on angle or tee iron brackets embedded not less than 115mm into walls. Pipework shall be secured to the brackets by U-bolts or mild steel stirrups bolted on.

Brackets shall generally be to the following Standards or as shown on the drawings or described in **Part 3** of this specification:-

- BS 1494:1964:Part 1 for pipe clips, brackets etc.
- BS 3974:1974:Part 1 for hangers, sliders and rollers.
- BS 3974:1978:Part 2 for clamps, cages, cantilevers and beam attachments.

Brackets fixed to walls shall be secured by purpose designed fixing devices, suitable for the application and service.

Pipework of 65mm size and larger subjected to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise specified.

Hangers for horizontal pipework at high level shall be supported from angle or channel irons, supplied by the Pipework Installer suitable for building in or otherwise securing to the structure. For steel pipework, adjustable mild steel hangers shall be used. Pipe rings shall be malleable cast iron or fabricated steel, made in halves and secured by bolts screws. Alternatively, malleable iron hinged pipe rings may be used or an approved proprietary support.

Where mechanical grooved pipe joints and fittings are specified, pipe supports and guiding must meet the minimum requirements of the Joint Manufacturer.

For copper pipework, pipe rings shall be brass or gunmetal, made in two halves and secured by bolts or screws.

2.18 PIPEWORK

Where pipework is fitted in ducts or trenches or where it is of 65mm size or greater and supported from walls, the design of the pipe supports, guides and anchors shall be designed by the Pipework Installer to take account fully of the expansion forces involved. Where roller supports are required that shall be of an approved type.

The preformed insulation shall be kept free of the rolling surface and when in external ducts or trenches insulation shall also comply with the specified clause. Load bearing insulation at supports, where required, shall be fitted by the Pipework Installer at the time of erecting the pipework.

On mild steel pipework, where required, mild steel anchors capable of resisting the maximum stresses shall be provided and preferably shall be welded to the pipework. The width of the straps shall be a minimum of twice the OD of the pipework.

Where it is impractical to weld the anchors to the pipework, cast iron chairs with at least two wrought iron stirrups shall be used, the bolts being provided with sufficient thread to ensure an effective grip on the pipe. For copper pipework the anchors shall be provided by wide copper straps to the pipework in such a manner that the pipe is not damaged. The width of the straps shall be a minimum of twice the OD of the pipework.

The Pipework Installer shall supply and fix in position ready for building-in all cleats, bracket and steelwork required for anchor points. Anchor steelwork secured to the bottoms of duct or trenches shall be coated with hot poured bitumen. Provision for movement due to expansion and contraction shall be made by changes in direction of the pipework, by loops, by mechanical grooved joints where specified or by special expansion joints. Supports, steadiers and guides shall be arranged to ensure that all movement is taken up by the change in direction of the pipework loop or joint. Where pipework is required to be pre-stressed for the purpose of reducing expansion stress under working conditions, the extent of the cold pull shall be indicated by the Pipework Installer on his drawings.

PIPEWORK SUPPORT INTERVALS

Pipework Support Intervals for Steel Pipework

For LPHW, MTHW, chilled water, condenser water, glycol, gas, oil, hot and cold water.

Size of Tube	Maximum Intervals for Horizontal Runs		Maximum Intervals for Vertical Runs
	<i>Bare</i>	<i>Lagged</i>	<i>Bare or Lagged</i>
mm	m	m	m
15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.7
50	3.0	2.4	3.7
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	4.0	3.0	4.6
125	4.5	3.7	5.5
150	5.5	4.5	5.5
200	8.5	6.0	8.5
250	9.0	6.5	9.0
300	10.0	7.0	10.0

The spacing of supports carrying pipework of various diameters and materials must be set out to satisfy the requirement of the pipe having the smallest spacing interval.

Where mechanical grooved pipe joints and fittings have been specified, pipe support spacing must satisfy both the above requirements and the requirements of the Joint Manufacturer.

Pipework Support Intervals for Copper Pipework

2.18 PIPEWORK

For LPHW, MTHW, chilled water, condenser water, glycol, gas, oil, hot, cold water and laboratory gases.

Size of Tube	Maximum Intervals for Horizontal Runs		Maximum Intervals for Vertical Runs
	<i>Bare</i>	<i>Lagged</i>	<i>Bare or Lagged</i>
mm	m	m	m
15	1.2	1.2	1.8
22	1.2	1.2	1.8
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0
54	2.7	1.8	3.0
67	3.0	2.4	3.7
76	3.0	2.4	3.7
108	3.0	2.4	3.7
133	3.7	3.0	3.7
159	4.5	3.7	3.7

The spacing of supports carrying pipework of various diameters and materials must be set out to satisfy the requirement of the pipe having the smallest spacing interval.

Where mechanical grooved pipe joints and fittings have been specified, pipe support spacing must satisfy both the above requirements and the requirements of the Joint Manufacturer.

Pipework Support Intervals for Plastic Pipework

Size of Tube	Maximum Intervals for Horizontal Runs		Maximum Intervals for Vertical Runs
	<i>Bare</i>	<i>Lagged</i>	<i>Bare or Lagged</i>
mm	m	m	m
15	0.75	-	1.5
20	1.0	-	1.8
25	1.0	-	1.8
32	1.0	-	2.0
40	1.2	-	2.4
50	1.4	-	2.8
65	1.4	-	2.8
80	1.8	-	3.5
100+	2.0	-	4.0

The spacing of supports carrying pipework of various diameters and materials must be set out to satisfy the requirement of the pipe having the smallest spacing interval.

THREAD SEALANTS

For Hot & Cold Water Services

Approved to Water Research Centre tests as suitable for potable water and proof against bacterial growth, ie. PTFE unsintered tape to BS 6974/BS 7786 or suitable and approved jointing materials to BS 5242/BS 6956.

2.18 PIPEWORK

For Natural Gas Service

Jointing materials shall be defined in the Institute of Gas Engineers Document IGE/UP/2:Section 6, ie. PTFE unsintered tape to BS 6974/BS 7786 or a suitable and approved jointing material to BS 5292/BS 6956.

PTFE unsintered tape shall be wound on spools marked "Satisfies IGE/UP/2" and state wrapping technique and size of pipe for which it is suitable.

For Other Services

PTFE tape as CWS for steam 40mm (1½") BSP and below, or 50mm (2") BSP and below for other services.

Proprietary approved brands of sealants or compounds as indicated above for threads 65mm (2½") BSP and above such as galvanised flanges if PTFE is not suitable.

ELECTROLYTIC ACTION

This must be prevented by the following actions:-

- By suitable means taken to ensure that dissimilar metals are not in contact where presence of water or moisture could promote electrolytic action.
- Where copper pipes connect to ferrous cisterns or equipment, whether galvanised or not, by means of approved fibre washers or gaskets.
- By avoiding the need to join copper pipes to galvanised steel pipes.
- By using pipe supports as under:-

Galvanised, malleable iron, or steel for steel or iron pipes.

Brass or gunmetal for copper, stainless steel or plastic pipes.

PIPEWORK FOR LTHW, MTHW HEATING, CHILLED WATER & CONDENSER WATER SERVICES (& ALSO DIESEL COOLING WATER)

Tube, unless otherwise noted, shall be black, mild steel, of heavy weight quality conforming to BS 1387:1985 generally for all tube sizes up to and including 150mm dia. with welded joints and forged seamless steel welding fittings to BS 1965:Part 1 for pipe sizes 65mm dia. and above, except where grooved fittings are specified.

On all tube sizes up to and including 50mm dia., screwed joints and fittings shall be used unless pipework is concealed or encased so as to be inaccessible then all joints shall be welded.

Pipe diameters larger than 150mm and up to and including 450mm shall be black mild steel to BS 3601, reference S430 or ERW430 unless specified otherwise in **Part 3** of this specification, with welding joints and forged seamless welding fittings to BS 1965. Fittings above 400mm to be to BS 1640, bore matched to tube.

Finish to all black steel pipes shall be one coat of rust-inhibiting paint.

Where indicated in **Part 3** of this specification or on the drawings that connections shall be terminated on black mild steel systems in copper to perimeter heating and heating and cooling terminal units it shall be carried out with copper tube conforming to BS 2871:Part1:Table X, and compression or capillary fittings to BS 864 used to suit application.

2.18 PIPEWORK

TABLE A	
ENTIRE PIPEWORK SYSTEM EXCLUDING DRAINS, OVERFLOWS, SAFETY VALVE DISCHARGES & CONNECTIONS TO PERIMETER FINNED TUBING, HEATING & COOLING TERMINAL UNITS	
Maximum Working Pressures & Temperatures of Systems as Defined in Part 3 of this Specification	
Test Pressure	1½ times maximum working pressure.
Test Duration	One hour plus visual inspection.
Pipe Material	15-125mm inc. BS 1387 black heavy weight mild steel tube. 200mm and above BS 3601.
Screwed Fittings	Black MI to BS 143 or BS 1256 (10-15mm only). Except nipples and sockets which shall be to BS 1387/1740.
Welded Fittings	BS 1965:Part 1.
Flanges	BS 4504, Types 4 and 5 rating 16 bar (except for mating flanges where valve or equipment details shall prevail).
Grooved Fittings	Victaulic or equal.
Pulled Bends	Cold 10-65mm.
Screwed Jointing	See Thread Sealants.
Flanged Jointing	Klingerite/Walkerite without compound or Taylor ring plus jointing compound.
Victaulic Jointing	20mm and above.
Bolting	Black steel metric hexagonal. BS 4190, Grade 4.2.
Pipe Sleeves	BS 1387 medium weight up to and including 150mm. Above 150mm minimum wall thickness BS 3601 tube.
Pipe Clip Material	Mild steel.
NOTE: Chilled Water System - Pipe brackets to be oversized to incorporate insulating block complete with vapour sealing sleeve. Alternatively, standard size lined clips with rubber grommet to hanger rod may be used. Thermal transmission must still be able to stop condensation.	

NOTE:

3601 wall thickness shall be as follows:-

200mm dia. = 5.6mm
350mm dia. = 10mm

250mm dia. = 7.1mm
400mm dia. = 10mm

300mm dia. = 8.0mm
450mm dia. = 12.5mm

TABLE B DRAINS & OVERFLOWS	
Pipe Material	Galvanised medium weight tube to BS 1387.
Screwed Fittings	Galvanised MI to BS 143 or BS 1256 only. Except nipples and sockets which shall be to BS 1387/1740.
Welded Fittings	If required black to BS 1965:Part 1 medium weight, galvanised after construction. 65mm to 150mm.
Flanges	Galvanised to BS 4504, Types 4 or 5 rating 16 bar (except for mating flanges where valve or equipment details shall prevail).
Grooved Fittings	Victaulic galvanised to BS 729.
Pulled Bends	Not permitted.
Screwed Jointing	See Thread Sealants.
Flanged Jointing	Klingerite/Walkerite without compound or Taylor ring plus jointing compound.
Bolting	BZP metric hexagonal to BS 4190 Grade 4.2.
Pipe Sleeves	Galvanised tube to BS 1387.
Pipe Clip Material	BZP mild steel.

TABLE C COPPER CONNECTIONS TO PERIMETER FINNED TUBING, HEATING & COOLING TERMINAL UNITS	
Maximum Working Pressures & Temperatures of Systems as Defined in Part 3 of this Specification	
Test Pressure	1½ times maximum working pressure minimum or 7 Bar.
Test Duration	One hour plus visual inspection.
Pipe Material	Light gauge half hard copper to BS 2871:Part 1:Table X.
Capillary Fittings	Solder Ring Yorcasal or equal copper fittings to BS 864:Part 2 (15-54mm only).
Compression Fittings	Conex/Prestex/Kuterite or equal. Gunmetal, Type A to BS 864:Part 2 (15-54mm only)
End Feed Flanges	To BS 864:Part 2 (15-54mm only).
Grooved Fittings	Victaulic "coparite" joints and fittings or equal.
Pulled Bends	Cold 10-35mm. Hot 42mm and above. Minimum radius 3D or 2D if prefabricated.
Jointing	Capillary solder ring and end feed fittings shall be used in conjunction with Fry's Powerflow or Laco Regular flux together with lead free solder.
Pipe Sleeves	Light gauge half hard copper to BS 2871:Part 1:Table X.
Pipe Clip Material	Brass or copper/plated with insulated liner
Pipe Clip Type	Split ring clip or lined clip.
NOTE: Compression joints to be used only for valve or, equipment connections, or for pipe terminations.	

2.18 PIPEWORK

PIPEWORK FOR STEAM & CONDENSATE

Unless otherwise stated, all fittings and components shall be manufactured by Spirax-Sarco.

Tube, unless otherwise noted, shall be black mild steel of heavy weight quality, conforming to BS 1387:1967 generally for all tube sizes up to and including 150mm dia., with welded joints and forged seamless steel welding fittings to BS 1965 for pipe sizes 65mm dia. and above.

Pipe diameters larger than 150mm and up to and including 450mm shall be black mild steel to BS 3601, reference S430 or ERW430 unless otherwise specified in **Part 3** of this specification, with welded joints and forged seamless steel welding fittings to BS 1965. Fittings above 400mm to be to BS 1640, bore matched to tube.

Grooved mechanical joints and fittings are not permitted on steam lines and may only be used on condensate lines up to a maximum temperature of 110°C, when specified in **Part 3** or shown on the drawings.

Finish to all black steel pipes shall be one coat of red oxide paint primer or equivalent.

On all tube sizes up to and including 50mm dia., welded or taper threaded, screwed joints and fittings shall be used unless pipework is concealed or encased so as to be inaccessible than all joints shall be welded. Valve connections up to 50mm screwed, over 50mm flanged.

Steam pipework connections to plant and equipment shall be flanged; alternatively, connections of 50mm bore or less may be spherical seated wrought iron unions.

Condensate systems, when specified to be copper, shall have suitable capillary or brazed joints (when specified in **Part 3**). Screwed joints may be used outside buildings or where a multiplicity of fittings occurs in the condensate system. The copper tube shall be seamless and comply with BS 2871:Part 2:Table 5 or BS.2871:Part 1:Table Y as specified in **Part 3** of this specification. The brazing or mechanical joints shall comply with BS 2051.

Steam and condensate mains shall be graded to fall in the direction of flow; the minimum gradient shall be 35mm in 10m. Drainage and relay points shall be provided at the lowest points in the mains. Drainage points and scale pockets shall consist of a short length of tube pointing vertically down from a tee on the main. The diameter of the tube and the connection shall be not less than 50mm or be the same diameter as the main. Pockets of up to and including 80mm dia. shall be not less than 50mm long and shall terminate in a screwed cap; pockets of 100mm dia. and above shall not be less than 300mm long and shall be flanged. The drainage connection shall be taken from a point at approximately 2/3 of the height of the pocket to a strainer and a steam trap.

Steam pipework joints shall be either welded or taper threaded up to 50mm bore; over 50mm bore they shall be welded. Connections to valves up to 50mm shall be screwed; over 50mm they shall be flanged.

Threaded fittings for copper pipework shall be of copper alloy to BS 143.

Unions or flanges may be used for connecting to traps, strainers and other items of plant and equipment.

Flanges for copper pipework shall be of a composite type complying with BS 4504:Part 2 comprising copper alloy inserts brazed to the tube with loose steel locking rings.

Pressure Testing

This shall be carried out after a preliminary inspection for leakage with the pipework full of water at normal pressure and shall be applied to completed sections of pipework finally to the whole installation and comprise the following hydraulic pressure using cold water, the pressure to be held for not less than one hour after rectification of any leakages:-

Test Pressure = not less than 1½ times boiler maximum working pressure.

2.18 PIPEWORK

Pipework shall be visually re-checked when steam is applied and the system is at working pressure and temperature and again after the system has been allowed to cool and steam is again introduced.

STEAM PIPEWORK	
Maximum Pressure	7.0 bar.
Maximum Temperature	170°C.
Test Pressure	12.0 bar (1½ times maximum working pressure) minimum.
Test Duration	One hour plus visual inspection.
Pipe Material	15-150mm inc. BS 1387 black heavy weight mild steel tube. 200mm and above BS 3601.
Screwed & Welded Flanges	Steam pipework fittings shall be of mild steel, seamless, complying with BS 1965:Part 1 for welded joints or of wrought steel heavy grade complying with BS 1740:Part 2 for screwed joints. Threaded fittings shall be malleable cast iron to BS 143 and BS 1256 or wrought steel to BS 1740.
Flanges	BS 4504.
Pulled Bends	Cold 10-65mm. Minimum radius 3D or 2D when prefabricated.
Screwed Jointing	See Thread Sealants.
Flanged Jointing	Klingerite/Walkerite without compound or Taylor ring plus jointing compound. Gaskets to BS 4865:Part 1 or BS 3063 as appropriate.
Bolting	Black steel metric hexagonal. BS 4190, Grade 4.2.
Pipe Sleeves	BS 1387. Medium weight up to and including 150mm. Above minimum wall thickness BS 3601 tube.
Pipe Clip Material	Mild steel.

CONDENSATE PIPEWORK

General

This section covers pipes, valves and fittings connecting outlets of trap sets to condensate collecting points, but does not include equipment such as trap sets, condensate receivers, hot wells etc., which are specified in **Part 3**.

Pipes and material, valves and fittings to be as described on the following tables as appropriate and shown on the drawings and specified in **Part 3**.

Pressure Testing

This shall be carried out after a preliminary inspection for leakage with the pipework full of water at normal pressure and shall be applied to completed sections of pipework and finally to the whole installation and comprise the following hydraulic pressure using cold water and the pressure being held for not less than one hour after rectification of any leakages:-

Test Pressure from trap set= 1½ x maximum working pressure of steam main.
(pressurised)

Test Pressure from trap set= 4 bar.g.
(atmospheric)

2.18 PIPEWORK

Pipework shall be visually re-checked when the system is at working pressure and temperature and again when the steam system has been allowed to cool and steam is again introduced.

CONDENSATE SERVICE:				
COPPER PIPES CAPILLARY OR FLANGED JOINTS				
Working Pressure = 7 bar.g maximum			Temperature = 185°C maximum	
ITEM	NOMINAL SIZE	DESCRIPTION	BS REF.	NOTES
Pipe	15 to 108	Copper tube. Plain end. Half hard. As drawn. Straight lengths.	2871:Part 1 Table Y	Bends not to have radius less than 3 x 0/dia. of pipe to centre line.
Fittings	15 to 54	Copper alloy. Capillary type 55/45 silver alloy brazing metal.	Makers Standards 1845 Table 2 Type AG14	“Steam” quality fittings. Integral solder rings.
Fittings	67 to 108	Gunmetal. Capillary type 50% silver alloy brazing metal.	Makers Standards 1845 Table 2 Type AG1	
Unions	15 to 54	Copper alloy. Capillary type 55/45 silver alloy brazing metal.	864:Part 2 1845 Table 2 Type AG14	“Steam” quality fittings. Integral solder rings.
Flanges (two-piece type)	22 to 108	MS flange. Copper alloy centre piece. Capillary type 40% silver alloy brazing metal. Flange PN16 bar.	4504:Part 2 1845 Table 2 Type AG20 4504:Part 2	Flanges to have coating against electrolytic action and corrosion.
Isolating Valve	½” to 2” 15 to 50 (reduced bore)	Stainless/carbon steel, aluminium & brass. Ball valve type. Wrench cleave operation. Screwed butt/socket weld.	5159 6755:Part 1 EN17	As manufactured by Worcester Controls (UK) Ltd - ref. AW44
Isolating Valves	65 & above (reduced bore)	Stainless/carbon steel. Ball valve type. Wrench sleeve operation. Screwed butt/socket weld.	5159 6755:Part 1	As manufactured by Worcester Controls (UK) Ltd - ref. 459
Check Valve	½” to 2”	Copper alloy. Swing type. PN7 bar. End connections screwed BS 21:1985. AMD 6633 12/90 taper.	5154:1991	Renewable discs.
Check Valve	65 & above	Cast iron. Swing type. GM trim. PN7 bar. Flanged.	5153:1974 4504:Part 3	Renewable discs.
Gaskets at Flanges	All sizes metric	Metallic spiral wound with support ring.	4865:1989 Part 2 Makers Standards	Asbestos-free materials.

2.18 PIPEWORK

CONDENSATE SERVICE: COPPER-NICKEL-IRON PIPES CAPILLARY OR FLANGED JOINTS				
Working Pressure = 7 bar.g maximum			Temperature = 185°C maximum	
ITEM	NOMINAL SIZE	DESCRIPTION	BS REF.	NOTES
Pipe	35 to 159	Seamless alloy pipes. 90/10 copper/nickel.	BS EN ISO 2781-2 Part 2 Table 5	
Fittings Unions	35 to 54	Copper alloy. Capillary type 55/45 silver/alloy brazing metal.	Makers Standards 1845:1984 CP1 Table 2 AG14	“Steam” quality fittings. Integral solder rings.
Fittings	54 to 159	Seamless brazing bends and fittings from tube socketed for capillary brazing. 15% silver/copper/phosphorus brazing metal.	2871:1984 Part 2 Table 3 1845:1984 Table 2 Type AG20	Type CN 102 alloy. Factory produced fittings.
Flanges (two-piece type)	35 to 159	MS flange. Copper alloy centre piece. Capillary type 40% silver brazing metal. Flanged PN16 bar.	4504:Part 3 1845:1984 Table 2 Type AG20	Flanges shall have protection against electrolytic action and corrosion.
Isolating Valve	1¼” to 2” 32 to 50	Stainless/carbon steel, aluminium & brass. Ball valve type. Wrench cleave operation. Screwed butt/socket weld.	5154:1984 4504:Part 3	As manufactured by Worcester Controls (UK) Ltd - ref. AW44
Isolating Valves	65 & above	Stainless/carbon steel. Ball valve type. Wrench sleeve operation. Screwed butt/socket weld.	5150:1990 4504:Part 3	As manufactured by Worcester Controls (UK) Ltd - ref. 459
Check Valve	1¼” to 2”	Copper alloy. Swing or lift type. PN16 bar. End connections screwed. BS 21 taper.	5154:1991	Renewable discs.
Check Valve	65 & above	Cast iron. Swing or lift type. GM trim. PN16 bar. Flanged.	5153 4504:Part 1	Renewable discs.
Gaskets at Flanges	All sizes metric	Metallic spiral wound with support ring.	4865:Part 2	Asbestos-free materials.

2.18 PIPEWORK

SECOND FAMILY GAS SERVICE (NATURAL GAS)

The installation shall generally conform with the Institute of Gas Engineers Publication IGE/UP/2 entitled - "Gas Installation Pipework, Boosters and Compressors on Industrial and Commercial Premises".

Jointing of Steel Pipework

Steel pipework shall be jointed as follows, in accordance with IGE/UP/2:Table 5:-

Size (Bore) mm	JOINTING METHOD								
	Below Ground			Above Ground			For Risers in High Rise Buildings or within Ducts		
	1	2	3	1	2	3	1	2	3
Up to 25	SCREW OR WELD			SCREW OR WELD			SCREW OR WELD		
26 to 50									
51 to 80	WELD			WELD			WELD		
81 to 100									
Above 100	WELD			WELD			WELD		

NOTE:

- 1 = 0 to 0.075 bar
- 2 = 0.075 to 2.0 bar
- 3 = 2.0 to 7.0 bar

Soundness Testing

This should be applied to the completed pipework installation by authorised personnel only generally in accordance with the Institution of Gas Engineers Publication - IGE/UP/1 entitled - "Soundness Testing and Purging of Industrial and Commercial Gas Installations".

Purging of Pipework

This should be carried out by authorised personnel only immediately following satisfactory soundness testing, generally in accordance with the Institute of Gas Engineers Publication - IGE/UP/1.

2.18 PIPEWORK

Comprise indirect purging using nitrogen in all cases except where direct purging using natural gas may be used as follows:-

- All pipe sizes with less than 10m run.
- Pipes up to 100mm dia. between 10m and 100m run.
- Up to 50mm dia. pipes for above 100m run.

Include for tests using oxygen measuring devices to ensure purging by nitrogen is complete, after which the pipework shall be purged using natural gas when the correct purging shall be tested by gas detection devices.

Include checks on all joints for gas leakage using a gas detector with the checks repeated after the pipeline has been charged with gas for 3-4 days.

Test Records

These should be based on IGE/UP/1 and provided to record satisfactory witnessed tests and procedures for soundness testing and purging.

Safety Precautions

Provide for the work area to be kept free from unauthorised personnel during testing and purging procedures and ensure that appropriate warning notices are displayed.

Ensure that the installation complies with the Gas Safety Regulations (1994).

Installation & Workmanship

This must be to a high standard carried out by skilled Installers experienced for the class of work and in particular fully trained in heat fusion jointing techniques in the case of yellow polyethylene pipework installations.

Require each Installer to present his certificate of competency to the Engineer for inspection and recording before commencing work on site and when he shall carry out work to the grade for which he is licensed.

Pipework shall be arranged for easy dismantling. For this purpose, the Pipework Installer shall provide unions at intervals of not more than 24m on pipework up to and including 50mm size and flanges on pipework over 50mm size. Flanges to be to BS 5404. Flanged joints shall be made with flat ring gaskets suitable for the pressure and extending the inside of the bolt circles.

A minimum clearance of 150mm shall be maintained between gas pipes and electric cables/conduits.

The MSC is to supply and fix, yellow handled ball-o-fix valves, to provide local isolation adjacent to doorway exits within the laboratories and plant rooms.

All new pipe work is to be painted with two coats of yellow ochre and banded with yellow tape marked "Gas" at 2m intervals.

2.18 PIPEWORK

PIPEWORK IN DUCTS OR ABOVE GROUND	
Pipe Material (10-150mm)	Black heavy weight tube to BS 1387.
Pipe Material (over 150mm)	Black tube to BS 3601.
Screwed Fittings	Black MI to BS 43 (10-50mm only).
Welded Fittings	Black to BS 1965:Part 1 heavy weight.
Welding	Minimum standard in compliance with BS 2971 or BS 2640.
Flanges	Black to BS 4504, Type 5 rating 16 bar (except for mating flanges where valve or equipment details shall prevail).
Pulled Bends	Cold 15-50mm.
Screwed Jointing	15-50mm - PTFE thread sealant tape to BS 6974 and BS 5292/BS 6956. Over 50mm - PTFE tape as above when Manufacturer has declared he can meet IGE test requirements.
Flanged Jointing	Taylor ring plus paste or Klingerite gasket without compound.
Bolting	Black steel metric hexagonal BS 4190, Grade 4.2.
Pipe Sleeves	Black mild steel sealed at either side of wall or floor face.
Pipe Clip Material	Black mild steel.
Uninsulated Pipe, Clip Type	2 bolt split band clip.

Pipework shall be arranged to gradual fall in the direction of flow with relay points and condensation pots at changes of level. Syphon markers and surface boxes shall be provided at each syphon point and all such surface boxes shall be set in substantial concrete surrounds.

COPPER PIPEWORK	
Pipe Material (15-67mm)	Light gauge copper tube to BS 2871:Part 1:Table X.
Fittings	Integral solder ring fittings or end feed fittings to BS 864:Part 2. Fittings for disconnection purposes in accessible locations may be compression to BS 864:Part 2.
Jointing	To be carried out strictly in accordance with Manufacturer's instructions of the fitting and jointing material, and comply with the following:- Capillary solder ring fittings and end feed fittings shall be used in conjunction with Fry's Powerflow or Laco Regular Flux. Fittings having threads screwed to BS 21.

Pipe In Pipe Systems

The gas carrying pipe and enclosing pipe of a pipe-in-pipe system shall be as previously described for pipework in ducts or above ground and to be prefabricated in sections for site assembly. Welded joints shall be used throughout.

2.18 PIPEWORK

Purpose made mild steel spacers, welded to the outside wall of the gas carrying pipe and the internal wall of the enclosing pipe shall be the means of support for the enclosed pipe. Spacers shall be designed for location adjacent to and either side of bends or tees, and at not more than 4m intervals in running lengths. Support of the enclosing pipe shall generally be as described for pipework.

Split inserts between or sleeves over shall be welded to the enclosing pipe sections to complete the pipe-in-pipe system after jointing of the gas carrying pipe sections has been completed and satisfactory testing carried out.

Gas carrying pipework to be wire brushed externally and painted one coat red oxide paint before incorporating within the enclosing pipe.

The enclosing pipe shall be identified as a gas installation pipe and marked with the size of the contained pipe.

Buried Pipework

Shall be in accordance with IGE/UP/2 (Section 8 in particular).

Buried pipework shall be in the following materials as specified in **Part 3**.

BURIED PIPEWORK - STEEL TUBE	
Pipe Material (15-150mm)	Black heavy weight tube to BS 1387 - double wrapped with self-adhesive plastic tape or petroleum impregnated woven cloth type. Wrapping shall only take place after testing has been successfully carried out.
Pipe Material (over 150mm)	Black tube to BS 3601 - double wrapped with self-adhesive plastic tape or petroleum impregnated woven cloth type. Wrapping shall only take place after testing has been successfully carried out.
Screwed Fittings	Black MI to BS 43 (15-50mm only).
Welded Fittings	Black to BS 1965:Part 1 and BS 10, 4504 and 1560.
Screwed Jointing	15-50mm - PTFE thread sealant tape to BS 6974 and BS 5292/BS 6956. Over 50mm - PTFE tape as above when Manufacturer has declared he can meet IGE test requirements. (PTFE tape shall be wound on a spool marked with the statement "Satisfies IGE/UP/2" and with the wrapping technique and size of pipe on which it is known to be suitable.)
Welding	2 bolt split band clip.

Pipework shall be painted before wrapping.

2.18 PIPEWORK

BURIED PIPEWORK - COPPER	
Pipe Material (15-28mm)	Light gauge copper tube to BS 2871:Part 1:Table Y, annealed condition and supplied in coils, and factory sheathed in yellow ochre polyethylene coating. (Use strictly limited to an “all copper” gas installation.)
Fittings	Copper alloy or gunmetal integral solder ring capillary fittings to BS 864:Part 2 or end feed fittings to BS 864:Part 2. An adhesive polythene or PVC waterproof tape shall be applied to the fitting and for a distance of 225mm either side of the fitting to maintain the protective coating of the tube - after satisfactory pressure testing has been carried out.
On Site Bending	Bending of tube to a radius of not less than that of the coil may be undertaken without using equipment incorporating formers and guides.
Jointing	To be carried out strictly in accordance with Manufacturer’s instructions of the fitting and jointing material, and comply with the following:- Capillary solder ring and end feed fittings shall be used in conjunction with Fry’s Powerflow or Laco Regular Flux together with lead free solder. Fittings having threads screwed to BS 21 to be made using PTFE thread sealant tape to BS 6974 and BS 5292/BS 6956 wound on a spool marked with the statement “Satisfies IGE/UP/2”.

BURIED PIPEWORK - POLYETHYLENE (MDPE)	
Pipe Material	Polyethylene pipe - yellow - to IGE specification to BS 7281.
Fittings	Compression couplings complying with British Gas specification BGS/PS/PL3 or BS 5114. Electrofusion fittings meeting requirements of BG specification solvent welding shall not be used.
Welding	Butt fusion jointing employing machine complete with clamps and hydraulic activation unit.
Jointing	To be carried out strictly in accordance with Manufacturer’s instructions of the fitting and welding process.

- PE pipework shall not be used within buildings.

2.18 PIPEWORK

Corrosion Protection of Buried Pipes

Pipework which is otherwise liable to corrode shall be protected appropriately. Tapes of the self-adhesive plastic or petroleum impregnated woven cloth types are considered suitable for wrapping pipes. Where a tape wrapping is employed, a minimum overlap of 50% shall be provided.

NOTE:

Appropriate methods include the application of self-adhesive plastic tapes, petroleum impregnated woven cloth tapes etc. The latter may need to be overwrapped with a waterproof covering of PVC tape.

Where steel pipework is laid in corrosive soils, the excavation shall be backfilled around the pipework with a passive material, eg. Dry washed sand or crushed limestone. In addition, such pipework shall be protected by tape wrapping of loose polyethylene sleeving.

For steel pipework, it is advisable to consider the use of cathodic protection, information being provided in BS 7361:Part 1.

The gas transportation company shall be consulted before cathodic protection is applied.

PE pipework shall not be laid in chemically corrosive soil, such as those containing tars, oils, plating, dry cleaning fluids etc., nor should it be exposed to temperature extremes encountered, for example, near a steam main.

BURIED GAS PIPE - MARKER PLATES & COVERING	
Marker Plates	To be indelibly marked with the word Gas or the letter G, of minimum size 150x150mm and fitted to convenient adjacent structure or special marker post to indicate position of valves, siphons and purge points (in accordance with IGE/UP/2 - 8.4).
Covering of Pipes	<p>Pipes exceeding 50mm should be laid with not less than 900mm of cover under roadways and grass verges and not less than 600mm of cover under paved footpaths.</p> <p>Pipes shall be buried in such a manner that:-</p> <ul style="list-style-type: none">• Accidental damage to the pipe, fittings and wrapping is unlikely.• They are guarded against physical damage from rocks, stones, sharp materials and the effects of traffic loading.• They are protected against chemical action caused by corrosive/contaminated soils and high tension power cables.

2.18 PIPEWORK

LABORATORY AND MEDICAL GASES

Installation

The installation shall comply with the BCGA Code of Practice - CP4 - Industrial Gas Cylinder Manifolds and Distribution Pipelines.

Pipework Materials

Shall be manufactured by a licensee of the BS 5750 Quality Assurance certification scheme and fittings up to 54mm and all pipes to be marked with the BSI kitemark and subject to the following requirements:-

Pipes

Shall be phosphorus de-oxidised non-arsenical copper to BS 6017:1981 (1989) grade C106. Pipe sizes and manufacture to be to BS 2871:Part 1 Table X and to include the marking "DEG" or "degreased", in addition to the marking requirements of BS 2871, to represent compliance with Element 01, Clause 04.

Fittings

Shall be phosphorus de-oxidised non-arsenical copper to BS 6017:1981 (1989) grade C106, of sizes and manufacture to be to BS 864:Part 2.

Extensions to Existing Installations

Shall:-

- Be subject to the requirements of the "Permit to Work" system.
- Be physically separated from the existing pipework and the final connection made only when all tests required on the new extension have been completed.

Brazed Pipeline Jointing

Shall:-

- For copper to copper joints made on site, utilise a copper phosphorus brazing alloy type CP1 or CP4 to BS 1845 and an inert gas shield and no flux.
- For copper to brass or gunmetal joints made off site, utilise a silver brazing material type AG13 or AG18 to BS 1845, a flux as recommended by the Manufacturer and the joint to be subsequently cleaned to meet the requirements in Element 01, Clause 04.

Pipe Preparation

Shall:-

- Include for pipe ends to be cut clean and square with the pipe axis, using wheel cutters where possible and de-burred, re-rounded and cleaned of cuttings.
- Provide for pipe ends and inside of fittings to be thoroughly cleaned.
- Include for the use of the correct pipe expanding tools when utilizing expanded tube joints. The expanded tube joint is only permitted for straight tube joints and on sizes up to and including 28mm.

2.18 PIPEWORK

Inert Gas Shielding

Shall:-

- Be provided internally for all on site fluxless jointing and hot forming of bends. The inert gas to be oxygen free grade nitrogen.
- Include for each cylinder or group of cylinders to be fitted with a pressure regulator and a means of providing and controlling a high flow flush purge and a low flow purge. The equipment to include all necessary hoses and pipe connectors, purpose made for N₂ purging only and specially identified.

Safety Measures

Shall:-

- Be taken during brazing with a shield gas to avoid contaminating confined areas, ducts etc. and, if necessary, ventilation to these areas is to be included or other means taken to remove the shield gas from the area.
- Be the responsibility of the Contractor who will provide and use detection equipment where necessary and inform the Engineer of any potentially hazardous situation.
- Include the recording of the use and removal from site of shield gas cylinders after installation work is completed.

Demonstration Joints

Shall:-

- Be provided to demonstrate the competence of craftsmen in fluxless brazing techniques, by making demonstration joints in advance of the installation.
- Comprise a maximum of 5 No. additional joints cut out of a completed installation at the Contractor's expense, before testing has started, and for their reinstatement.
- If any one of these joints is proved to be unsatisfactory, include for further joints to be cut out and re-made until the extent of the defective joints has been established.
- Be considered satisfactory when:-
 - (a) the penetration of brazing alloy is a minimum of 3mm at any point.
 - (b) the internal surface is clean and free of oxide when wiped with a tissue or cloth.

Mechanical Pipeline Jointing

Shall:-

Be used only when connecting pipework to plant and equipment items.

Flammable Gases

Acetylene gas storage shall comply with the BCGA Code of Practice - CP No. 6 "The Safe Use of Acetylene in the Range 0 - 1.5 Bar."

Acetylene manifolds shall conform to BCGA T.I.S.- N0 4, BS EN ISO 14114 "Acetylene Manifold Systems for Welding, Cutting & Allied Processes: General Requirements".

The manifold shall be equipped with all necessary safety devices eg. non-return valves, flame arrestor and safety shut-off valve to comply with HSE requirements for a system operating between 0.6 Bar and 1.5 Bar.

2.18 PIPEWORK

The acetylene manifold shall be separated from the other gases in a 2-hour fire rated chamber. Acetylene pipework passing through the chamber where oxygen is stored shall have no joints and the pipework penetrations of the gas storage chamber wall shall be carefully and effectively sealed.

Particular attention shall be paid to the safety aspects of this installation.

Acetylene distribution pipework shall be carried out in black heavy weight mild steel tube to BS 1387, joints shall be welded.

Hydrogen gas storage shall comply with the BCGA Code of Practice CP No. 8 - "The Safe Storage of Gases Hydrogen in Seamless Cylinders and Similar Containers."

The hydrogen manifold shall be located in the same gas storage chamber as the inert gas manifolds. Where the hydrogen pipeline passes through the store containing the oxygen manifold the pipe shall be jointless and the pipework penetrating the wall of the store containing the oxygen manifold shall be carefully sealed.

ABS PIPEWORK

ABS pipework shall only be installed within buildings.

Working Pressure 6 Bar g Nominal			Temperature (see notes)	
Item	Nominal Size	Description	British Standard	Notes
Pipe	mm 25 - 100 80 - 100 10 - 100	ABS Pressure Pipe Straight Lengths Straight Lengths Straight Lengths	5391:Part 1 Class C Class D Class E	
Fittings Sockets Tees Bends etc.	10-100	ABS Solvent Welding Fittings	5392:Part 1	
Unions	10-50	ABS Solvent Welding Socket/BSP Thread		
Flanges Full-Face Type Two-Piece Type	12-40	ABS Solvent Welding Socket ABS Solvent Welding Socket centre stub with mild steel loose flange	4504:Part 3 Section 3.1 1989 AMB 6610:9:1990 6334:1:1991 7555:6:1993 Section 3.2:1989 Section 3.3:1989 AMD 6274:11:1989	
Isolating Valves	10-100	ABS Valves Diaphragm or Ball Type. Ends as required. Socket screwed or flanged	4865 Part 1	To the approval of WRC tests
Gaskets at Flanges		To Manufacturer recommendation to suit quality of water		

2.18 PIPEWORK

PIPEWORK FOR OIL SERVICES

General

This element covers pipes, valves and fittings connecting storage tanks to burners, including fill, vent and distribution lines, for heavy and light grade oils.

All materials shall be resistant to chemical reaction with the grade and temperature of oil being used as specified in **Part 3** and the following materials shall not be used - yellow brass; low grade copper and zinc alloys; lead; zinc; cadmium; aluminium; galvanised metals; natural rubber.

Pipes, valves and fittings to be selected from the appropriate tables in this specification to suit the service conditions and as shown on the drawings, or as specified in **Part 3**.

Steel pipework shall have all welded joints with standard butt welding fittings or where specified in **Part 3**, mechanical grooved joints and fittings fitted with a suitable gasket for the application.

Tube, unless otherwise noted, shall be black, mild steel, heavy weight quality, conforming to BS 1387:1967 generally for all sizes up to and including 150mm dia., with welding fittings only to BS 1965. Tube to BS 3601 over 150mm dia.

Finish to all black, mild steel pipes shall be one coat of red oxide primer, or equivalent.

Copper pipe shall be used only for feed pipes and shall be to BS 2871:Table X. Fittings for copper pipework up to and including DN50 shall be of the capillary or compression type to BS 864:Part 2. Fittings shall be non-dezincifiable.

OIL - ENTIRE PIPEWORK SYSTEM (MAXIMUM PRESSURE)	
Test Pressure	Hydraulic test minimum 1½ times working pressure or 7 bar whichever is greater. Suction tubes subjected to sub-atmospheric pressure tested to negative pressure 0.3 bar to BS 5410:Part 2.
Test Duration	One hour.
Pipe Material	Black heavy tube to BS 1387 up to and including 150mm. Tube to BS 3601 larger than 150mm.
Screwed Fittings	Not allowed.
Welded Fittings	Black to BS 1965:Part 1 medium weight, 65mm to 150mm. 200mm to 400mm inclusive wall thickness to match tube.
Flanges	Black to BS 4504, Type 5 rating 16 bar (except or mating flanges where valve or equipment details shall prevail).
Grooved Fittings	Victaulic joints and fittings fitted with a Nitrile gasket suitable for the application, when specified in Part 3 .
Pulled Bends	Cold 10-50mm. Hot 65mm and above. Minimum radius 3D, 2D if prefabricated.
Flanged Jointing	Taylor ring plus stag or equal jointing compound or Klingerite universal gasket without compound.
Bolting	Black steel metric hexagonal to BS 4190, Grade 4.2.
Pipe Sleeves	Black mild steel tube to BS 1387 medium weight.
Pipe Clip Material	Mild steel.
Uninsulated Pipe, Clip Type	2 bolt split band clip.

2.18 PIPEWORK

Pressure Testing Oil Services

Pressure testing shall be applied to the completed installation and comprise the following hydraulic pressure using water, in accordance with BS 5410:Part 2.

Test Pressure = $1\frac{1}{2}$ x working pressure or 7 bar.g, whichever is the greater. The pressure being maintained for not less than one hour after rectifying any leakages.

Immediately after the satisfactory completion of the tests, the water shall be completely drained and the pipework scavenged with dry compressed air to remove any water droplets.

If there is any possibility of water being retained in the system it shall be re-tested using a light grade fuel oil.

DOMESTIC HOT & COLD WATER SERVICES & MAINS WATER SERVICES

Pipework shall be arranged with adequate connection points to allow easy dismantling.

Joints on copper pipework 67mm dia. and above shall be by gunmetal brazing, flanges or where specified in **Part 3**, mechanical grooved joints suitable for copper pipe or brazed joints providing flanged or mechanical joints are installed in locations not exceeding 12m apart.

Joints on copper pipework 54mm dia. and below shall be by means of pre-soldered capillary fittings with compression fittings for valves and final connections to equipment or where necessary to facilitate removal.

All pipework in positions not readily accessible in wall chases, cavities and floor trenches shall have brazed joints.

Gunmetal flanges shall be of the slip on pattern, faced and drilled and bronze welded to the mains. Drilling and dimensions of flanges shall be in accordance with the Tables in BS 4504. Flanges shall be bolted together with the necessary hexagonal nuts, bolts and washers, under the nut and bolt heads. Bolts, nuts and washers shall be phosphor bronze.

Flanged joints shall be bolted up using all faced corrugated brass rings. Bolts shall be of such length that when screwed tight the end of the bolt shall project not less than 3mm and not more than 6mm beyond the nut.

Pre-cleaning and sterilisation shall be carried out as specified elsewhere.

Cylinders and calorifiers shall be provided at their lowest points with key operated gland cocks having hose unions. Alternatively, the emptying cocks shall be connected into a common drain run with a visible discharge to waste.

Except where specified elsewhere, 15mm size key operated cocks with hose unions shall be fitted at all low points of DHWS and cold water systems to ensure complete drainage.

Where a pipe dips under a door into an accessible floor chase, a 15mm size plugged outlet shall be fitted to DHWS and cold water systems. Where dipped pipes are buried in the floor, the plugged outlet shall be omitted.

Pipes, valves and fittings for HWS and CWS services shall comply with both the Local Water Undertaking Bye-Laws and lists of approved materials as tested by the Water Research Centre (WRC) and listed in the current water fittings and materials directory.

All cold water services shall be classed as potable unless specifically stated in **Part 3**.

2.18 PIPEWORK

The installation of potable services should comply with the National Water Council Technical Paper No. 2 - Water Supply Hygiene.

No materials used in the construction or assembly of the services shall support microbial growth with the water circuits.

Pressure Testing

Hot Water Services

The pressure testing of the hot water services shall be generally to Code of Practice CP 342:Part 2 and be carried out after a preliminary inspection for leakage with the system full of cold water under normal pressure.

It shall be applied to completed sections of pipework and finally to the whole installation and comprise the following hydraulic pressure using cold water, the pressures to be held for not less than one hour after the rectification of any leakages:-

Test Pressure = 2 x normal maximum working head or 4 bar.g, whichever is greater.

Include for flushing out the system, refilling, bringing up to temperature and all circuits regulated for satisfactory flow.

Provide for the system to be allowed to cool and held in this condition for three hours and any leakage during these expansion and contraction tests rectified and the tests repeated.

Cold Water Services

The pressure testing of the cold water services shall be generally to BS 6700:1987 or as specified in **Part 3** and carried out after a preliminary inspection for leakage with the pipework full of water at normal pressure.

It shall be applied to completed sections of pipework and finally to the whole installation and comprise the following hydraulic pressures which must be held for not less than one hour after the rectification of any leakages:-

Service Pipework (Mains Pressure)

Test Pressure = 2 x maximum mains pressure for ductile iron or copper pipes or 10 bar.g, whichever is greater, and

1½ x maximum mains pressure for polyethylene pipes or 10 bar.g, whichever is greater.

Distribution Pipework (Cistern Supplies)

Test Pressure = 2 x maximum static head or 4 bar.g, whichever is greater.

Replace by a new section if leaking occurs at polyethylene pipework joints.

2.18 PIPEWORK

DOMESTIC HOT & COLD WATER SERVICES & MAINS WATER SERVICES

PIPEWORK INSTALLED IN PLANTROOMS, RISER DUCTS, FALSE CEILING SPACES & ON WALL SURFACES	
Material	Light gauge copper tube to BS 2871:Part 1:Table X.
Fittings	Non-dezincifiable integral lead free solder ring fittings or non-dezincifiable end feed fittings to BS 864:Part 2. Fittings for disconnection purposes to BS 864:Part 2. Non-dezincifiable non-manipulative BS 864:Part 2:Type A compression fittings, to include male/female thread to BS 21. Proprietary grooved fittings when specified in Part 3 .
On site Bending	Up to 54mm dia. may be carried out using equipment which incorporates formers and guides to support pipe walls against collapse, and without corrugations occurring in the bend throat.
Jointing	To be carried out strictly in accordance with Manufacturer's instructions of the fitting and jointing material, and comply with the following:- <ul style="list-style-type: none"> • Capillary solder ring and end feed fittings shall be used in conjunction with Fry's Powerflow or Laco Regular Flux together with lead free solder. • Type A compression fittings may be lubricated with Bossblue jointing compound. • Fittings having threads screwed BS 21 to be made using PTFE tape up to and including 42mm dia., GT PTFE tape with Bossblue 54mm to 150mm dia. • Flanges using proprietary non-asbestos and elastomeric joint rings complying with BS 2494:Type W and/or vulcanised fibre rings complying with BS 6091 or BS 5292/BS 6956:Part 1. • Mechanical grooved fittings suitable for copper pipe when specified in Part 3.
Bolting	In accordance with BS 4882.
Pipe Sleeves	Copper tube to BS 2871:Table X with annular space around pipe sealed with non-corrosive material.
<i>(Table continued overleaf...)</i>	

2.18 PIPEWORK

DOMESTIC HOT & COLD WATER SERVICES & MAINS WATER SERVICES

PIPEWORK INSTALLED IN PLANTROOMS, RISER DUCTS, FALSE CEILING SPACES & ON WALL SURFACES	
<p><i>(Table continued...)</i></p> <p>Pipe Clip</p>	<p>Non-ferrous pipe ring with plated ferrous threaded rod to floor soffit/wall surface with appropriate self-drilling insert.</p> <p>Non-ferrous pipe ring with plated ferrous threaded rod with secured connection to multi-service support/hanger bracket.</p> <p>Ferrous insulated hanger as Flamco or equal, supported on plated ferrous threaded rod from appropriate self-drilling insert into floor soffit or with secured connection to multi-service hanger bracket.</p> <p>Closed nylon clip with appropriate fixing to structure or supporting framework.</p>
<p>Chromium Plating</p>	<p>Pipework exposed to view in toilets and areas normally accessed by building occupier shall be chromium plated unless otherwise specified. Chromium plating shall be carried out to pipework only after erection to establish correctness of the installation and re-fitted using the necessary chromium plated fittings and fixings.</p>
<p>Flexible Connections</p>	<p>Final connections to sanitary appliances may be made unless otherwise specified using flexible synthetic elastomer material having an outer braiding in stainless or galvanised steel wire having double crimped end ferrules. End connectors shall be in brass or bichromated steel, swivel female and cone seat at one end.</p>

2.18 PIPEWORK

DOMESTIC HOT & COLD WATER SERVICES & MAINS WATER SERVICES

UNDERGROUND PIPEWORK - COPPER	
Material	Light gauge copper tube to BS 2871:Part 1:Table Y, annealed condition and supplied in coils, and having works applied blue polyethylene coating. Pipe diameters - 15mm to 28mm.
Fittings	Copper alloy gunmetal compression fittings to BS 864:Part 2:Type B non-dezincifiable manipulative compression type. An adhesive polythene or PVC waterproof tape shall be applied to the fitting and for a distance of 100mm either side of the fitting to maintain the protective coating of the tube - after satisfactory pressure testing has been carried out.
On site Bending	Bending of tube to a radius of not less than that of the coil may be undertaken without using equipment incorporating formers and guides.
Jointing	To be carried out strictly in accordance with Manufacturer's instructions of the fitting and jointing material, and comply with the following:- <ul style="list-style-type: none"> • Compression fittings may be lubricated with Bossblue jointing compound. • Fittings having threads screwed to BS 21 to be made using PTFE tape.
Covering of Pipes	Pipes shall be laid not less than 1000mm and not more than 1.35m from the finished ground level. Care shall be exercised in excluding all hard sharp objects from the floor of the pipe trench and 50mm of surrounding backfill to preclude damage to pipe and protective coating.
Pipe Sleeves	Pipes entering the building shall be sleeved or ducted, and sealed around the pipe at its external location.
Valve Pits & Covers	By others.

2.18 PIPEWORK

DOMESTIC HOT & COLD WATER SERVICES & MAINS WATER SERVICES

UNDERGROUND PIPEWORK - POLYETHYLENE PIPEWORK	
Material	Blue polyethylene pipe to BS 6572, 20mm to 63mm, and supplied in coils.
Fittings	Fittings manufactured from dezincification resistant alloy, gunmetal and copper; with copper pipeline support liners; to BS 864:Part 4 (to be published).
On site Bending	Bending of tube to a radius of not less than that of the coil may be undertaken.
Jointing	To be carried out strictly in accordance with Manufacturer's instructions of the fitting and jointing material, and comply with the following:- <ul style="list-style-type: none">• For 50mm and 63mm size fittings may be lubricated prior to assembly.• Fittings having threads screwed to BS 21 to be made using PTFE tape up to 42mm dia. and GT PTFE tape with Bossblue over 42mm dia.
Covering of Pipes	Pipes shall be laid not less than 1000mm and not more than 1.35m from the finished ground level. Care shall be exercised in excluding all hard sharp objects from the floor of the pipe trench and 50mm of surrounding backfill to preclude damage to pipe and protective coating.
Pipe Sleeves	Pipes entering the building shall be sleeved or ducted, and sealed around the pipe at its external location.
Valve Pits & Covers	By others.

Levels of external water pipes shall be adjusted to enable water mains to cross other services without mutual hazard, i.e. cables will normally be arranged to pass over water mains preserving a minimum clearance of 100mm at the point of crossing. Water mains will be diverted down to pass below existing cables.

Water mains will be arranged to set below sewers, drains etc if 200mm clearance cannot otherwise be maintained.

Water mains will set below heating pipes and heating ducts in every case.

Water mains diversions to pass other services shall be carried out by the use of slow bends and shall be suitably restrained at each change of direction.

PIPELINE ANCILLARIES

Regulating & Isolating Valves

General

Valves shall be provided of the type as specified in the schedules and where shown on the drawings for the efficient and easy control balancing and isolation of each and every part of the systems. Drain cocks complete with hose union tails shall also be provided at all low points in the system and wherever required for the emptying of isolated sections of the installation, or of items of plant.

Isolating valves shall be installed adjacent to each float valve, motorised valve or control valve, mixing valve and all items of equipment including pumps, cooling and heating coils, boiler, refrigeration plant, calorifiers, tanks etc.

2.18 PIPEWORK

All valves shall be in-line size unless otherwise indicated on the drawings or in the schedules.

As far as possible, the type and manufacture of valves shall be consistent throughout the installation in order to rationalise holding of spares.

All valves must comply with the requirements of all the Local Water Authority for the services for which they are used and WRC approved.

Where indicated on the drawings or schedules, valves shall be lockable.

Valves and cocks in mild steel pipework up to and including 50mm size have taper screwed ends, and 65mm size and above shall have flanged ends, unless otherwise specified. Valves and cocks on copper pipework shall have ends as for fittings.

Stop taps or cocks shall be of approved types and located in positions accessible for operation and maintenance.

All HTHW valves shall be capable of operating at temperatures up to 130°C.

Labelling of Valves

All plantroom valves and every circuit control valve shall be provided with a label with a reference number.

A valve chart shall be provided in each plantroom in a glazed frame. It shall contain a circuit control diagram showing locations and numbering of valves with a brief description of their function.

Isolation Valves

(LTHW, MTHW, Chilled Water, Condenser Water, Glycol)

Isolation valves shall be provided to isolate items of equipment or circuits as indicated on the drawings. The valve types shall be as follows OR as separately defined later in **Part 3** of this specification or in the schedules:-

Gate Pattern			
15 - 50mm	Holmes	Fig. 1400X	Screwed
	Hattersley	Fig. 30	Screwed
	Crane	Fig. D151A	Screwed
	Tour & Andersson	Fig. TA64	Screwed
65mm and above	Hattersley	Fig. M541 (PN16)	BS 4504 (16 Bar)
	Crane	Fig. FM63	BS 4504 (16 Bar)
	Holmes	Fig. 1412	BS 4504 (16 Bar)
	Tour & Andersson	Fig. S1750	BS 4504 (16 Bar)
65 - 300mm	Hattersley	Fig. M541GSB	Grooved Ended

Ball Seated			
15 - 50mm	Worcester	Fig. AW44	Screwed butt/socket weld
	Holmes	Fig. 1800	Screwed
	Crane	Fig. D171A	Screwed
	Hattersley	Fig. 100	Screwed
	Ballofix		Compression
	Hattersley	Fig. 100C	Compression
	Tour & Andersson	Fig. TA500	Screwed
		Fig. TA500C	Compression

2.18 PIPEWORK

Butterfly Valves

Butterfly valves shall be lever operated up to and including 150mm. Gear operated may be used on 100mm and above as specified in Part 3 or on the drawings. The butterfly valves shall be of the following types unless specified in Part 3 and the schedules:-

<u>Lugged Pattern</u>			
50 - 200mm	Tour & Andersson	Fig. TA36 Fig. TA36G	Lever Op. Gear Op.
50 - 300mm	Holmes	HK 222EL	BS 4504 (16 Bar)
	Holmes	HK 222NL	BS 4504 (16 Bar)
50 - 600mm	Holmes	HK 222EG	BS 4504 (16 Bar)
	Holmes	HK 222NG	BS 4504 (16 Bar)
65 and above	Bestobell	Fig. JMC (GRI-SAPAG)	BS 4504 (16 Bar)
	Crane	GEM.F624/625	BS 4504 (16 Bar)
50 - 150mm	Hattersley	Fig. 970 Lever Op.	BS 4504 (16 Bar)
200 - 300mm	Hattersley	Fig. 970A Gear Op.	BS 4504 (16 Bar)
<u>Semi-Lugged Pattern</u>			
50 - 200mm	Tour & Andersson	Fig. TA35 Fig. TA35G	Lever Op. Gear Op.
Up to 150mm	Hattersley	Fig. 950	Lever Op.
Above 150mm	Hattersley	Fig. 950G	Gear Op.
	Bestobell	Fig. JMC	
	Crane	Fig. F714/715	
<u>Mono Flanged</u>			
50 - 300mm	Holmes	HK 221EL	
	Holmes	HK 221NL	
50 - 600mm	Holmes	HK 221EG	
	Holmes	HK 221NG	
65mm and above	Bestobell	Fig. JMH	
350 - 600mm	Hattersley	Fig. 960G	Gear Operated
<u>Grooved</u>			
65 - 200mm	Victaulic	Fig. 940GSB	
65 - 300mm	Hattersley	Fig. 940GSB	
50 - 300mm	Bestobell	Fig. JPL (For fire protection only)	
<u>Spherical Ball Valve with Integral Strainer</u>			
15 - 50mm	Marflow Filter Ball		

2.18 PIPEWORK

Balancing Valves - Double Regulating (LTHW, Chilled Water, Condenser Water, Glycol)

The following untapped valves or equal unless specified later in **Part 3** shall be provided to regulate water flow quantities as indicated:-

Globe Type			
15mm low flow	Hattersley	Fig. 1473	Screwed
	Holmes	Fig. BV 391	Screwed
	Tour & Andersson	Fig. MD22	
15 - 50mm	Hattersley	Fig. 1432	Screwed
	Crane	Fig. D920	Screwed
	Holmes	Fig. BV 301	Screwed
	Tour & Andersson	Fig. MD20	
65 - 300mm	Hattersley	Fig. M733DR (PN16)	BS 4504 (16 Bar)
	Hattersley	Fig. M733DRGSB	Grooved
	Hattersley	Fig. M737GSB	Grooved Variable Orifice
	Crane	Fig. DM920	BS 4504 (16 Bar)
	Holmes	Fig. BV 203	BS 4504 (16 Bar)
	Tour & Andersson	Fig. MDF2	
Butterfly Type			
65mm and above	Holmes	Figs. BV 361 and BV 371	
	Hattersley	Figs. 953 and 953G	
65 - 200mm	Victaulic		Grooved

Non-Return Valves (LTHW, MTHW, Chilled Water, Condenser Water, Glycol)

Check valves shall be of the swing type as indicated and shall be installed in the horizontal position wherever possible. The valve types shall be as follows or equal unless stated otherwise in **Part 3** or the schedules:-

Swing Check Type			
15 - 50mm	Holmes	Fig. 1461	Screwed
	Hattersley	Fig. 47	Screwed
	Crane	Fig. D138	Screwed
	Tour & Andersson	Fig. TA27	
65 - 200mm	Victaulic	Fig. 717	Grooved
65 - 300mm	Hattersley	Fig. M651 (PN16)	BS 4504 (16 Bar)
	Crane	Fig. FM492	BS 4504 (16 Bar)
	Holmes	Fig. 1464	
	Tour & Andersson	Fig. TA250	
Wafer Type			
65 - 300mm	Holmes	Fig. 1467	
	Tour & Andersson	Fig. TA252	
65 - 400mm	Hattersley	Fig. 850	
50 - 300mm	Crane	Fig. FM450	
	Keystone	Fig. 85	
50 - 600mm	Stockham	Duo-Chek II	

2.18 PIPEWORK

Diaphragm Pattern

15 - 50mm	Norval	Diaphragm Type CD/S
65mm and above	Norval	Diaphragm Type CD

Radiator Valves

Thermostatic Radiator Valves

Thermostatic Radiator Valves shall be provided for all radiators and shall be as specified in **Part 3**. If not specified, they may be either:-

Hertz 7000 series supplied by Ellis Miller Ltd or Drayton TRVA Range supplied by SIEBE Controls Ltd Hattersley Delflow 87 or Tour & Andersson RVT/TRV 310.

Radiator Lockshield Valves

Radiator lockshield valves shall be:-

Hattersley Delflow 2407 LS OR equal. Hattersley Delflow 2386LS Angle Pattern or equal. Crane D891 POL. Tour & Andersson Trim A Straight. Tour & Andersson Trim A Angle.

Commissioning Valve Sets (LTHW, MTHW, Chilled Water, Condenser Water, Glycol)

Commissioning valves sets shall be provided to balance the various water circuits and shall be located where indicated on the drawings. They shall be selected for the particular application to the Supplier's guidelines, and shall be from the following Manufacturers/Suppliers, unless specified otherwise in **Part 3** or the schedules:-

Globe Pattern

Holmes Valves Ltd Hattersley Newman Hender Crane Bailey Tour & Andersson Ltd
--

Butterfly Pattern

Hattersley Holmes-Keystone

2.18 PIPEWORK

Safety Valves - Heating Systems

Safety valves for pressure and temperature shall be provided as indicated on drawings and shall be as follows and sized in accordance with the Manufacturer's recommendation and as required by the relevant British Standard:-

15 - 50mm	NABIC 42	(pressure only)	Screwed
	NABIC 501	(pressure and temperature)	Screwed
65 and above	NABIC 42	(pressure only)	BS 4504 (16 Bar)
	NABIC 501	(pressure and temperature)	BS 4504 (16 Bar)

3-Way Safety Cocks

The following 3-way vent and safety cock **only** shall be used as specified for boilers and calorifiers:-

15 - 50mm	NABIC	Fig. 175	Screwed
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Needle Valves

The following or equal needle valves **only** shall be used where indicated for venting pipework:-

8 - 20mm	Hattersley	Fig. 5N	Screwed
	Crane	Fig. D71	Screwed
	Holmes	Fig. 1426/T	Screwed
	Tour & Andersson	Fig. TA15	

Drain Cocks

Drain cocks shall be provided where indicated. They shall be as follows or equal:-

Wet Systems			
15 - 25mm	Hattersley	370	Screwed
15 mm	Crane	D341	Screwed
	Holmes	Fig. 1483	Screwed
	Tour & Andersson	Fig. TA470	
15 - 50mm	Hattersley	81 HU	Screwed
	Crane	D344.5	Screwed
	Yorkshire		Screwed
	Holmes	Fig. 1481	Screwed
	Tour & Andersson	Fig. 18HU	
Dry Systems			
For dry systems, the following drain cock shall be used:-			
15mm	Hattersley	Fig. 369	Screwed
	Crane	Fig. D341	Screwed
	Tour & Andersson	Fig. TA471	

Flushing Drain Cock

These shall be 50mm minimum (or line size if smaller). They shall be gate valves of Manufacturer's figure number scheduled above under Isolation Valves.

2.18 PIPEWORK

Manual & Automatic Air Vents

Air vents shall be provided as indicated on the drawings and shall be as follows or equal:-

Manual Hattersley		Fig. 425	Screwed
AAV	Winns	Type B, Fig. 425	Screwed
AAV	Spirax	Fig. AE 30 CV	Screwed
AAV	Engineering Appliances	Spirotech	Screwed

Automatic air vents shall only be installed where indicated on the drawings. Vents shall have a float and integral valve plug with seat to discharge chamber. The discharge chamber shall have a tapped port for drain line extension.

A servicing valve shall be installed between the main and the air vent. Drain lines shall be extended to the nearest open drain with the discharge arranged so that it is readily accessible and visible.

Lubricated Plug Valves

16 - 50mm	Newman Milliken	170 M	Screwed
65 - 200mm	Newman Milliken	171 M or 171 MG	Flanged

Valves for use with Domestic Hot & Cold Water Services & Landing Valves

Valves up to and including 54mm dia. shall be manufactured from gunmetal or non-dezincifiable brass, and marked to show the appropriate BS number and Kite Mark, and be listed within the WRC Water Fittings and Materials Directory. Valves of 65mm dia. and over may be of cast iron, marked to show appropriate BS number and pressure rating, and listed within the WRC Water Fittings and Materials Directory. They shall be suitable for not less than 1½ times the operating pressure of the system and have a minimum pressure rating of PN16.

2.18 PIPEWORK

Internal

Supply Pipe Stop Valve	15 - 54mm BS 1010 screw down pattern. Over 54mm BS 5154 gate pattern. 65mm and over BS 5163.
Outlets from Storage Cisterns & Isolating Valves	15 - 100mm BS 5154 gate pattern. 65mm and over BS 5163.
Servicing Valves	15 - 22mm screwdriver or key operated. 25 - 100mm as described for Isolating Valves.
Double Check Valves	15 - 35mm BS 6282.
Check Valves	15 - 54mm swing check as listed in the WRC Directory. 15 - 100mm spring loaded check valve as listed in the WRC Directory.
Float Operated Valves	15mm BS 1212:Part 2 of Part 3. 22mm and over BS 1212:Part 1 incorporating, if necessary, a drop arm assembly to permit adjustment of water level without bending the arm. 22mm and over equilibrium pattern as listed in the WRC Directory. (Floats to be obtained from Supplier of the valve.) 22 - 54mm Warner Arclion Type A delayed action valve incorporating BS 1212:Part 1 float operated valve. 20 - 40mm the Aylesbury float valve having rotating ceramic discs as manufactured by Keraflo Ltd.
Draining Taps	15 - 25mm BS 2879:Part 2.
Thermostatic Blending/Mixing Valves	15-25mm complete with strainers, non-return valves, service valves etc. all in accordance with Local Water Authority and as listed in the WRC Directory.

2.18 PIPEWORK

External

External Water Mains	At all teed branches on trunk water mains a minimum of 3 isolating valves (anti-clockwise closing) shall be provided, upstream and downstream of tee, and on branch.
Supply Pipe Stop Valve	15 - 54mm BS 5433 screw down pattern. 54 - 150mm BS 5163 flanged gate valve with wheel or cap and key operated as appropriate.
Fire Valves	Cast iron hydrant valve to BS 750 and having captive stoppers.
Landing Valves	Flanged (65) or screwed end (2½) copper alloy handwheel operation valve to BS 5041 having integral/screwed on outlet of the female instantaneous pattern. The valve shall be complete with leather strap and non-ferrous padlock for securing valve in closed position (not usually required where valve is to be in a box).
Inlet Breaching Landing Valves	Horizontal/vertical mounting 20-way breaching constructed to meet the requirements of BS 5041 incorporating spring loaded non-return valves at the instantaneous 2½ hose coupling inlet ports. Complete with 1" drain valve, inlet port bank caps, and flanged/screwed outlet.
Boxes for Landing Valves for Dry Risers	Box of robust construction and resistant to corrosion with glazed and hinged lockable door, having the words "Dry Riser" clearly painted in block letters, all in accordance with BS 5041. To be handed to Builder for building in.
Boxes for Dry Riser Inlets	Box of horizontal/vertical pattern to suit inlet breaching, of robust construction and resistant to corrosion with glazed and hinged lockable door, having the words "Dry Riser Inlet" clearly painted in block letters, all in accordance with BS 5041. To be handed to Builder for building in.

Fire Hydrants

Hydrants shall be mounted onto duckfoot hydrant bends the base of which shall be cast into the hydrant pit after test. 80mm x 80mm hydrant bends may be used when coupling to an 80mm main, but 100mm x 80mm hydrant bends shall be provided in all other cases.

The level of all hydrants shall be arranged so that the top of the stem adaptor shall be not less than 50mm below finished ground level and not more than 200mm. Any adjustment of level to meet this requirement shall be made by the introduction of a double flanged make up piece between the hydrant bend and the base of the hydrant proper.

Sluice Valve & Hydrant Surface Boxes

The setting in position and supervision of the installation of the requisite sluice valve surface boxes and hydrant surface boxes for all external valves and hydrants shall be carried out in accordance with Contract Procedures.

Sluice valve and hydrant surface boxes shall, without exception, be of extra heavy quality "Class A Road Quality" designed to withstand a safe central point load of 5,000kg.

2.18 PIPEWORK

Leading dimensions of surface boxes shall be approximately as follows:-

	Hydrant Boxes	Sluice Valve Boxes
Type	Rectangular	Circular
Cover Type	Chained Captive	Hinged Captive
Clear Opening	275mm x 125mm	100mm
Bottom Flange Overall	525mm x 375mm	250mm
Minimum Depth	150mm	25mm

Fire hydrants surface boxes shall have covers with FH cast in letters.

Sluice valve surface boxes shall have covers with W cast in letters.

Sluice valve covers shall be orientated in such a manner that a person reading the letter “W” shall be facing in the direction of flow of the water in the main beneath.

The construction of hydrant pits and sluice valve pits will be by independent contract but the Engineering Services Contractor shall set out positions, and supply typical details incorporating leading dimensions of all such pits, and supervise the setting of the surface boxes.

Hydrant Markers & Hydrant Plates & Sluice Valve Markers

Each fire hydrant and each sluice valve shall be provided with an approved indicator post, with BS 3251 Cast Alloy “Hydrant” or “Water” plate with “main diameter” and “location” numerals fitted.

The location of all hydrant and sluice valve markers shall be in accordance with the Contract Procedures.

Valves for Second Family Gas Service (Natural Gas)

Valves to be as recommendations in IGE/UP/2 - Section 16, in particular Table 11.

Underground

All Sizes : Steel or iron valves having smooth low operating torque incorporating a “ball” which is turned through 90° between fully open and fully closed position.

50mm and Over : Conduit valves having thin parallel sided gate sliding between the valve seats. The gate to incorporate a circular port the diameter of the valve bore.

(Valves capable of easy closure after long periods in the open position and requiring little or no servicing - any maintenance to be capable of being carried out whilst the valve is insitu.)

Above Ground

- **At Secondary Meters**

Non-lubricated plug valves up to 50mm, lever operated and travelling through 90° between fully open and closed positions.

Lubricated plug valves up to 75mm, lever operated and travelling through 90° between fully open and closed positions. Over 75mm wheel head/geared actuators.

2.18 PIPEWORK

• Section Isolation

Non-lubricated plug valves up to 50mm, lubricated plug valves and ball valves as specified for use at secondary meters. (Valves must be fire resistant.)

• Plant Isolation

Non-lubricated plug valves up to 50mm, lubricated plug valves and ball valves as specified for use at secondary meters.

• Non-Return Valves

Installations shall be protected from back pressure, or pressure propagation by explosion, by the installation of light non-return valves of approved pattern, appropriately located in the installation.

Installations serving laboratories and technical installations shall be arranged in conveniently small sections, each protected by a non-return valve, and the maximum floor area protected by any single non-return valve shall not exceed 400m².

An additional non-return valve shall be provided in the gas supply connection serving any pressurising equipment (eg. gas booster) or any pressurised appliance (eg. oxy-gas torch).

Valves for Fuel Oil

Valves shall have gunmetal bodies as specified in **Part 3** and shall be fitted in accessible positions as indicated on the drawings.

STRAINERS

LTHW, Chilled Water, Condenser Water, Glycol

Strainers shall be provided as shown on the drawings and be “Y” pattern and complete with removable stainless steel screen. Strainers larger than 50mm shall be provided with drain cock and shall be flanged or grooved.

Standard baskets shall have 0.75 mm dia. holes. Strainers in association with low lift valves shall have baskets with suitable mesh of a smaller size to meet Valve Manufacturer’s requirements. Unless otherwise indicated, strainers, except those serving individual coils, shall be provided with a test point either side of strainer.

15 - 50mm	Hattersley	Fig. 807	Screwed
	Crane	Fig. D297	Screwed
	Tour & Andersson	Fig. TA640	
	Spirax-Sarco	Fig. 12	Screwed (NB 0.8 mesh)
50 - 300mm	Tour & Andersson	Fig. TA651	
65mm and above	Hattersley	Fig. 810	Flanged
	Crane	Fig. FM276	Flanged
	Victaulic		Grooved
	Spirax-Sarco	Fig. 37	Flanged (NB 0.8 mesh)

FLEXIBLE CONNECTIONS

Chilled Water, Condenser Water, LTHW

Flexible connections shall be soft spherical form neoprene rubber joints with reinforced convolutions and be of the tied elbows type.

Flexible connections shall be fitted as indicated on the drawings. Stool pieces or spacers shall be fitted during the pipework installation prior to installation of flexible connection.

2.18 PIPEWORK

Flexible Water Service Connections to Sanitary Appliances

Connections to terminal water fittings at sanitary appliances may, where specified in **Part 3**, be made with flexible piping connections. These shall comprise a synthetic elastomer inner liner enclosed in stainless steel or galvanised steel wire braiding and stainless steel double crimped end ferrules. Terminal water fitting connection shall incorporate a swivel union.

BELLOWS EXPANSION JOINTS

Expansion joints shall be of the articulated or axial type as indicated and shall be provided with screwed or flanged ends as appropriate. They shall incorporate internal liners if required and shall be manufactured from a corrosion-resistant steel, or other approved material appropriate to the duty, and designed to withstand the test pressure of the system.

Expansion bellows for angular movements shall be provided with the rods or hinges to take end thrust.

All bellows expansion joints shall be provided with external protection where exposed to damage. For axial bellows, this shall comprise an external sleeve.

Bellows shall be installed so that they are not subjected to stresses other than those for which they are designed. They shall be installed so that they are in their "free position" at a temperature mid-way between the high and low limits of normal service.

Bellows expansion joints shall be provided with guides to ensure that all movements are taken up in the proper manner. The Manufacturer's recommendations shall be closely followed. Guides shall be secured rigidly and shall provide free movement for expansion without undue tolerance. Means for lubrication shall be provided where necessary.

When installing expansion bellows, care is to be taken to ensure that the pipework on both sides is anchored before the bellow is placed in position and the connection made.

STEAM ANCILLARY COMPONENTS

All steam ancillary components shall be Spirax as defined in **Part 3** of this specification.

THERMOMETERS

A thermometer shall be fitted to measure the flow and return temperature in each circuit, and on flow and return connections to items of plant as indicated on the drawings and specified in **Part 3**.

Unless specified otherwise in **Part 3** or on the drawings, they shall be to BS 5235 mercury in steel dial type with 100mm minimum diameter dial, white faced with black figured scale, complete with integral vertical or centre stem and separate pocket (brass or steel) to suit the immersion position and matt paint finish to casing and bezel.

They shall be installed using heat conducting grease and be calibrated in Celsius with divisions at 1°C intervals and numbered at 10°C intervals, the scale ranges being:-

0 - 50°C	Cold Water Service
0 - 100°C	Heating/Hot Water Service

Where a fixed working temperature is being measured, they shall have a loose red pointer set to that point.

2.18 PIPEWORK

ALTITUDE & PRESSURE GAUGES

Altitude and pressure gauges shall be provided where indicated on the drawings and specified in **Part 3**.

With the exception of domestic systems, pressure gauges shall be provided at suction and delivery ports of all pumps and altitude gauges shall be provided at boilers and calorifiers.

Unless specified otherwise in **Part 3** or on the drawings, they shall be generally to BS 1780:Part 2 with 100mm minimum diameter dial, white faced with black figures scale calibrated in bar or metre head to approximately 1½ times the working pressure specified in **Part 3** complete with lever handle (pressure gauges to have a ring or “U” pattern siphon) and adjustable red pointer set at normal working pressure/head of the system.

They shall be finished matt paint for both casing and bezel and calibrated in metres head of water for altitude gauges, bar or millibar for pressure gauges (0.10 Bar) and millimetre Hg for vacuum.

The steel tube to BS 3059:Part 2 shall be provided in the case of siphons filled with water prior to being put into service.

TRACE HEATING

Where specified in **Part 3** and shown on the drawings, trace heating shall be as Raychem Wintergard or as otherwise specified for the frost protection of insulated water services defined using self-regulating trace heating tapes designed to maintain a minimum temperature of 3°C.

Where valves etc., occur in pipelines adequate means must be provided for removal and operation of such fittings without damage to heating tapes, and mechanical protection of tapes provided at flanged joints, entry through cladding and connection points. Vapour sealing shall be applied to insulation entries and connection points.

The self-regulating trace heating cables shall be installed straight traced and thermal insulation should be applied without delay.

The trace heating cables shall be terminated with Rayclic connection and gel seals, with no heat shrinkable components in use.

All pipework with electrical trace heating shall be provided with suitable warning signs, at a spacing of not more than 3m apart.

The chilled water pipework trace heating circuits shall be controlled by a line sensing thermostat.

The Mechanical Contractor shall ensure that the Cable Manufacturer has available a trained and capable Field Engineer or Technician for providing technical support and installation training.

The trace heating systems shall be installed, tested and terminated strictly in accordance with the Manufacturer’s instructions.

Each trace heating circuit shall be protected electrically by use of Type 3 or Type 4 circuit breakers to BS EN 60898 or equivalent in combination with residual current devices, and sized in strict accordance with the Manufacturer’s instructions. These shall form an integral part of the motor control panel or local distribution board.

Wiring between the trace heating circuit terminal boxes and the mechanical control panel will be by the Controls Specialist unless otherwise specified in **Part 3**.

Isolators for each circuit shall be provided by the Controls Specialist unless otherwise specified in **Part 3**.

2.18 PIPEWORK

PIPEWORK CLEANING & WATER TREATMENT

The following shall be carried out as detailed in the “Commissioning and Testing” section of this specification.

HVAC Pipework Cleaning

The following HVAC pipework systems shall be pre-commission cleaned to remove grease, scale, corrosion products and biological fouling, and shall be treated and dosed to reduce the onset of corrosion, algae, biological and bacterial growth unless specified otherwise in **Part 3**:-

- Heating Systems.
- Chilled Water Systems.
- Glycol Systems.
- Condenser Water Systems.
- Heat Reclaim Systems.

Together with any other system defined in **Part 3**.

Pre-Commission Cleaning of HVAC Pipework Systems

The Contractor shall employ an approved Water Treatment Specialist who shall carry out the pre-commission cleaning and initial water treatment of the pipework systems listed above.

The Water Treatment Specialist shall select the cleaning method from one of the following methods after assessing each systems suitability and specific requirements and agree this with the Engineer:-

- Inhibited Acid Cleaning.
- Polymer Cleaning (with or without side stream filtration).
- Formulated Product Cleaning using a proprietary formulation.

The Contractor shall advise the Water Treatment Specialist of all materials, fillings, components, jointing materials and plant within the systems and receive written confirmation that the chemical cleaning materials will not cause any harmful effects in the long or short term.

Pre-commission cleaning shall be carried out in accordance with:-

- The flushing techniques contained in the BSRIA Applications Guide 8/91.
- The advice of the Water Treatment Specialist.
- The Contractor’s cleaning method statement prepared and agreed during the course of the contract.

The Contractor shall seek the advice of the Water Treatment Specialist in respect of the following:-

- The provision of system cleaning facilities.
- The method and application of any chemicals to be used.

The cleaning method statement shall include:-

- The method of carrying out the dynamic flushing of the pipework.
- The method and application of the cleaning chemicals.
- The method of final flushing.
- The application of the inhibitor and any other chemical treatment following the cleaning process.

2.18 PIPEWORK

Potable Water Pipework Cleaning

The following potable water pipework systems shall be pre-commission cleaned and disinfected using chlorination:-

External cold water mains.
Domestic hot and cold water systems and storage.

General

On completion of the potable water services, and after all testing is complete, the entire installation, shall be thoroughly and efficiently sterilised in accordance with British Standard Code of Practice and BS 6700:1987.

The sterilisation shall be carried out by a specialist firm in consultation with the Local Water Authority.

Initial Flush

The water circuits shall be fully flushed with mains water, to remove swarf, scale etc., and then drained with dirt pockets being removed. Drain cocks, dirt pockets, air vents shall be installed whether indicated on tender drawings or not, to complete the flushing cleaning process and sterilisation.

The sterilisation shall be carried out generally as follows:-

- (a) Warning notices shall be displayed at every outlet on the system and at all relevant control valves.
- (b) All storage tanks shall be first be inspected and any debris found shall be removed. All storage tanks, calorifiers and hot and cold distribution services, including pumped services where applicable shall be thoroughly flushed with clean water to remove detritus. The storage tanks shall then be re-filled, and whilst filling, an appropriate sterilant containing chlorine shall be added gradually to ensure thorough dispersal. This sterilant is to be approved by the local water authority. Sufficient sterilant shall be added to obtain a minimum dosage level of 50 parts of chlorine to one million parts of water (50 p.p.m.).

All chlorine levels must be determined chemically and this may be by comparator method. If "Chloros" is used, 0.5 litres of chemical added per 1,000 litres of water should be sufficient to obtain this dosage level.

All calorifiers, hot and cold distribution services (including pumped services where applicable) and each outlet, served by storage tanks shall be run until the chlorine level in and at each of these is above 50 p.p.m.

At all times the chlorine level in the storage tanks must be monitored and maintained above 50 p.p.m. by adding more sterilant if necessary. Before the sterilisation of the mains, the storage tanks must be allowed to reach their maximum operating levels.

All cold distribution services and each outlet not served by storage tanks within this system, shall be sterilised by injection. Whilst sterilant is being injected, all services and outlets shall be run until the chlorine level in and at each of these is above 50 p.p.m. This is to be carried out without risk of contamination to the existing system.

- (c) The entire mains water system and drinking water system shall be sterilised by injection. Whilst sterilant is being injected, all services and outlets shall be run until the chlorine level at each of these is above 50 p.p.m.

This is to be carried out without risk of contamination to the statutory authority's main, or where applicable, the existing system.

2.18 PIPEWORK

- (d) The entire system shall be left fully charged and with a chlorine concentration of not less than 50 p.p.m. throughout. The Contractor shall be responsible for maintaining the system in this condition and ensuring that no water is drawn from it by others.
At this stage, all cistern lids and storage tank covers must be in their fixed positions and remain so from this point onwards. After a contact period of not less than 3 hours, tests for residual chlorine shall be carried out at random points on each system. If any of these tests reveal that the chlorine level has dropped below 20 p.p.m. the sterilisation programme shall be repeated until satisfactory levels are obtained. The entire system shall be left undisturbed for a further 12 hours.
- (e) Upon the successful completion of the sterilisation, the entire installation shall be thoroughly flushed until the chlorine level throughout the system and at every outlet is below 0.3 p.p.m.. The warning notices may then be removed.
- (f) Samples of water shall be taken for bacteriological analysis after all flushing is complete.

The techniques for sampling and examination to ensure proficiency of laboratory practice, and comparability of results and the interpretation of these results, shall be as recommended in H.M. Government Report "The Bacteriological Examination of Drinking Water supplies 19872".

The samples shall be obtained from a suitable test point from each of the services detailed below, where applicable:-

- (i) Mains water service entering building
- (ii) Extremity of the mains water and drinking water distribution service.
- (iii) Extremity of the new cold water distribution service.

The biological examination of each and every sample must show the waters to be free from contamination and of a potable standard before the sterilisation programme may be regarded as effective. (NB. the only exception to this will be if the mains water entering the site is conclusively determined to be of poor quality, and this must be confirmed by the Local Water Authority).

Legionnaires Disease - Tests for Legionella bacteria in hot & cold water systems shall be carried out. The tests shall be carried out by the Public Health Laboratories on samples taken from representative sampling points when the systems are at working temperature and conditions.

Temperature of the water at the sampling point shall be recorded at the time of taking the sample.

Upon receipt of satisfactory results the systems may be regarded as fully operational.

No further or additional work, including draining down, shall be carried out on the systems, as this may result in a re-chlorination being called for.

- (g) The appropriate reports and certificates relating to the sterilisation programme and bacteriological examinations shall be submitted.

Pipework Cleaning Records

Records of the effectiveness of the pipework cleaning shall be included in the operating and maintenance manual.

Samples of the cleaned water prior to and after inhibiting shall be retained on site for the duration of the contract for inspection by the Engineer.

2.18 PIPEWORK

HOT AND COLD WATER SERVICES

The MSC is to supply and fix, Broen ballofix valve terminations, directly below (within 0.5m) any new water outlet points. The MSC is also to make all final connections using braided flexible connections.

Hot and cold water taps are to be installed to the University of Reading's standard, where hot taps are on the left hand side and cold taps are on the right hand side (when facing the appliance)

Drain-off points are to be installed under all sinks, basins and low points.

Internal hot & cold water supplies together with mains cold water, are to be installed in copper tube (BS 2871: part 1 table x). Galvanised pipe work may be used subject to the approval of the URME.

PIPE WORK ARRANGEMENTS

Mild steel pipe work fixings are not to be installed by shot firing. Drop rod supporting channels are to be used for sub brackets.

Copper pipe work is to be supported by brass munson rings. Steel pipe work is to be supported by cast iron munson rings. Plastic pipe work is to be supported with manufacturers approved plastic clips

All pipe work is to be securely fixed in accordance with the industries recommendations

Piped services positioned in a horizontal plane will be installed as far, as is reasonably practical from top to the bottom, in the following order:

HEATING FLOW
HEATING RETURN
HOT WATER
COLD WATER
NATURAL GAS
DEMINERALISED WATER.
OTHER

Minimum clearance between pipes and/or pipe insulation.

From ceilings	- 50mm depending upon skirting and coving arrangements
From floors	- 150mm depending upon skirting and coving arrangements
From walls	- 15mm
Between pipes	- 25mm
Electrical conduit and cables	- 150mm

All pipe work is to be run parallel, to each other.

All visible pipe work within room spaces is to be painted with two coats of gloss paint. Colour to be advised.

2.19 THERMAL INSULATION

General Considerations

All thermal insulation and methods of application shall comply with the requirements of the current British Standards and Codes of Practice including, but not limited to:-

BS.476, BS.874, BS.2972, BS.3533, BS.3927, BS.3958, BS.3974, BS.5422, BS.5588:Part 9, BS.5608, BS.5970, BS.7572; and the Building Regulations 1991 including approved documents and any amendments.

All insulation materials, adhesives and finishes shall be in compliance with BS.476:Part 4, non-combustibility test; or obtain a Class "O" fire rating to Building Regulations to BS.476:Parts 6 and 7 and shall not be flammable or support combustion.

Facing materials including any/all adhesives, fixing, vapour barrier and finishing material bonded to the insulation shall achieve a minimum of Class "O" rating. Certification of faced material shall state the nature of the facing material, the type and weight of adhesive, the Manufacturer of the substrate, its density and any other factors pertinent to the fire performance of the system. Materials must meet the approvals of the Local Building Control Officer and Fire Authority.

All insulation materials shall be:-

- Inherently proof against rotting, mould and fungal growth and attack by vermin.
- Free from animal hair or setting under vibration.
- Non-hygroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.
- Covered/finished by materials of weather-proof quality for outdoor (external) situations.
- Wholly compatible with the material it is insulating at the design working temperature and environmental conditions.
- Suitable for specific conditions or use without the physical properties falling outside the tolerance allowed in the appropriate British Standard.
- Free from chemicals which may contribute to corrosion or degradation of the insulated surface or finish.
- Capable of being applied to any of the following metal surfaces without causing corrosion under normal working conditions:-
 - Aluminium, Mild Steel, Cast Iron, Wrought Iron, Copper, Brass,
 - Gunmetal, Bronze, Lead and Galvanised Surfaces.
- Comply with the Health & Safety at Work Act and COSHH Regulations.
- Asbestos Free. (Where any work is carried out on existing thermal insulation material or finish which contains asbestos in any form, the Contractor's attention is drawn to his responsibilities under the provisions of the Asbestos Regulations 1969.)
- First class quality new materials delivered to site fully dried out and housed in dry store until ready for use.

2.19 THERMAL INSULATION

Installation Requirements

The installation shall include:-

- The supply and installation of all materials, plant, equipment, appliances and accessories necessary to form a complete and thorough installation, in accordance with BS.5970 and as detailed in **Part 3** of this specification.
- The correct thickness, thermal conductivity, fire rating and density of insulation installed complies with the requirements of this specification and relevant ISO/British Standards. Insulation not complying with these requirements shall be removed and replaced with new insulation to the requirements free of charge.
- The whole of the thermal insulation works is carried out by skilled Craftsmen used to the class of finish that is required.
- Standards specified rigidly adhered to and submit with his tender a list of Specialists from whom he proposes to make his selection for supplying and erection of insulation. No additional Specialists will be subsequently considered without prior approval in writing.
- Insulation on plant and pipework shall not be commenced unless otherwise approved until the whole of the installation has been cleaned, pressure tested and all joints proved sound and system in working order.
- Unless otherwise specifically mentioned, thickness shall mean the thickness of the insulation medium, excluding any surface covering, after application.
- Sections formed to fit closely to pipes generally in 1m minimum lengths except for closing pieces, cleanly cut neatly formed and mitred at bends, branches etc.
- Sufficient space is allowed when erecting and fitting pipework for the application of insulation and that it is close fitting to all pipes with joints sealed with pipes and separately insulated (marrying together will not be allowed).
- All nameplates are covered with removable sections of insulation that are easily identifiable.
- The insulation shall be applied such that plant and equipment can be cleaned and inspected with allowance made for removal of access covers, bolts, nuts and probes without damage to the insulation.
- All surfaces to be insulated are fully prepared in strict accordance with the Manufacturer's recommendation installation instructions and BS.5970:1992.
- Where insulation is laid to large flat surfaces tags (which he shall supply and fix) are passed through the insulation and secured with washers so that the insulation is held tight to the metal surfaces throughout.
- Care is taken to ensure that where required a complete vapour seal is maintained. In particular, the insulation to and around the points where supports, brackets and hangers occur on chilled and cold water services to ensure provision of a complete barrier to moisture transmission.
- All exposed ends of insulation are sealed to prevent migration of fibres and then capped with suitable protective capping adequately fixed.
- Adequate precautions are taken against any hazard to health involved in the use of any solvent, cleaner or materials.

2.19 THERMAL INSULATION

- Where an insulated pipe/duct passes through an external building element adequate precautions shall be taken to prevent entry of rain water into the building.
- At pipe and duct sleeves the finished insulation shall be carried through pipe sleeves. The annular space between insulation finish and sleeve shall be packed with non-flammable and fire retarding material to form fire stop.
- Phenolic foam when used must be CFC free in its manufacture.
- In instances where phenolic foam sections are applied to copper pipework, the pipework shall be clean and dry prior to the application of the insulation. Care shall be taken to ensure that in all cases where there is a likelihood of the copper pipework coming into contact with raw foam, a bore coating is incorporated into the phenolic foam.
- Insulation is protected against mechanical damage during the progress of the work and maintained dry as appropriate.
- Insulation or finishes are not painted with aluminium-based paints where used in the vicinity of flammable liquids or flammable gases, nor in the vicinity of pipes carrying flammable liquids or gases, due to the possible risk of an explosion.
- That where insulation with a sheet metal surface finish is used, eg. aluminium stucco sheeting etc., it complies with BS.7671 (equivalent to the IEE Regulations 16th Edition) and all subsequent additional and amendments as regards the facility to be electrically bonded to a protective conductor. The bonding shall be carried out under the electrical aspect of the works but the facility for connections to be included for by the Contractor in his tender. Insulation of pipework, ductwork or plant, finished with aluminium sheeting, or any other metal (but not aluminium foil), also to be bonded.
- Included in the tender is a price for making good any sections cut out during the inspections made to check compliance with the specification after completion.
- Included in the tender is a price for the removal of surplus materials from this place of work and the depositing of rubbish at locations on the site to be determined.

Attention is drawn to the risk attached to the use of PIB (polyisobutylene), polyurethane, polystyrene or isocyanurates etc., even where these materials are claimed to be fire resistant and/or self-extinguishing, they have proved in the past to produce toxic smoke causing a hazard to persons working in the area and to fire fighting teams. These types of insulation or finish **shall not** be used inside of a building or areas under cover. PVC also falls into this category. PIB may be used external to the building **only** if specified in **Part 3**.

Vapour Barriers

Shall:-

- be applied over insulation on plant etc., working at or below ambient temperatures and where specified later in this specification.
- be applied over the insulation and its coverage/finish on refrigeration, cold or chilled water and warm/cooled air services.
- be continuous, maintained dry, completed and sealed as a vapour barrier throughout before reducing the service to its working temperature. The water vapour permeance of the finished installation not to exceed 0.01 g/s (MN)) when tested in accordance with BS 3177, or for thicker materials, Method 8 of BS.4370:Part 2:1993.

2.19 THERMAL INSULATION

- be aluminium foil laminate as detailed in 04.02 with a minimum thickness of 0.02mm (foil) or as specified later in this specification.
- ensure that a complete vapour seal exists between permanent and removable insulation and that the vapour barrier seal returns to the pipework on either side of the flange or valve.

The glands on the valve spindles shall project beyond the insulation.

Where specified, make provision in any valve and flange boxes to accommodate trace heating of the pipework.

Have external valve and flange boxes suitably weather-proofed and sealed as for the pipework to which they are attached. Valve boxes shall include removable covers over handwheels and stems; see also BS.5970:1992.

Valve/flanged joints in plantrooms which are non-vapour sealed and are liable to be used/broken frequently may be filled with flexible multi-lag covers achieving a Class "O" rating (muffs), and suitable for the temperature range of the service if specifically specified in **Part 3** or on the drawings.

Vapour barrier insulation finishes must be effectively sealed and maintained with the materials specified. Where sealing tape is used it must be approved by the insulation Manufacturer and securely fixed to the insulation with an approved (or self) adhesive coating.

Insulation of Pipework & Ductwork Supports

Insulation, which must also provide a vapour seal, must be continued over the pipe supports and shall be sealed at the point where the hanger, clamp or other anchorage protrudes. Insulated pipe supports shall comply with BS.3974:Part 1 and BS.5970:1992.

The insulation shall have the vapour barrier and finish carried over the support liners.

All pipework and ductwork brackets/supports shall be installed around the outside of the thermal insulation and vapour seal.

The insulation at all support points shall be pre-formed load bearing inserts manufactured from hardwood, phenolic foam or other specified material, and to the same thickness as the adjacent insulation on each side of the bracket/support. Each insert shall incorporate a bright aluminium foil outer covering to provide a vapour barrier to match that of the adjacent insulation.

The length/width of each hardwood insert shall protrude not less than 40mm on either side of the bracket/support. The insulation either side of the bracket/support shall butt up tightly to the insert and the vapour barrier made continuous by taping the joints between the foil faces on the insulation and inserts with a minimum 50mm wide Idenden T303 Class "O" foil tape.

For HTHW, steam and condensate pipework where roller and chairs form the supports, a 2mm thick galvanised sheet steel protective sleeve shall be provided around the hardwood insert between the roller and guide bracket (phenolic foam shall not be used on HTHW and steam pipework or other systems that exceed its temperature limit).

All pipe inserts, and where required protective sleeves, shall be provided and installed with the pipe bracket.

All inserts at duct supports shall be provided and installed with duct support by the Contractor.

As it is essential to maintain the vapour seal, all duct supports shall conform to methods as outlined in DW/144.

2.19 THERMAL INSULATION

Insulation for Pipework in External Trenches/Ducts

Pipework insulation in external covered trenches or ducts shall be phenolic foam or mineral fibre insulation sections or other material specified in **Part 3**, with aluminium foil outer finish. In trenches/ducts liable to flooding the insulation shall be suitably weather-proofed. The installation of the insulation to comply with the requirements of this specification and also BS.7572:1992 as applicable.

Thermal Conductivity & Density of Insulating Materials

Unless otherwise stated later in this specification, thermal conductivity values shall be in accordance with BS.874 and BS.2972.

Mineral Fibre Preformed Sections

Normal bulk density: 80 to 110 kg/m³.
(120 kg/m³ - high temperature - above 250°C).
Thermal conductivity not exceeding 0.04 W/mK (ref. 50°C mean temperature).

Mineral Fibre Resin Bonded Slabs

Normal bulk density: 45 to 60 kg/m³.
(120 kg/m³ - high temperature - above 250°C).
Thermal conductivity not exceeding 0.04 W/mK (ref. 50°C mean temperature).

Mineral Fibre Flexible Mattress (Ductwrap)

Normal bulk density: 45 kg/m³.
Thermal conductivity not exceeding 0.04 W/mK (ref. 50°C mean temperature).

Mineral Fibre Lamella Mattress

Minimum Normal bulk density: 40 kg/m³.
Thermal conductivity not exceeding 0.04 W/mK (ref. 50°C mean temperature).

Phenolic Rigid Foam, Preformed Sections & Slabs (CFC Free)

Normal bulk density: 35 to 40 kg/m³.
Thermal conductivity not exceeding 0.02 W/mK (ref. 10°C mean temperature for chilled and cold water services).

Expanded Nitrile Rubber (Armaflex Class "O" or Equal)

Thermal conductivity not exceeding 0.039 W/mK (ref. 10°C mean temperature for chilled and cold water services).

SERVICES TO BE INSULATED

The services to be insulated shall include the following as applicable and as further defined in **Part 3** of this specification and on the drawings.

The type of insulation and finish shall be as defined in **Part 3** of this specification.

- All LTHW, MTHW and HTHW pipework, except where exposed pipework is used for heating.
- All steam and condensate pipework.
- All chilled water pipework.
- All condenser cooling water pipework.

2.19 THERMAL INSULATION

- All cold water pipework, except pipework exposed to view in toilet areas.
- All domestic hot water service pipework except pipework exposed to view in toilet areas.
- All external pipework.
- Fire services pipework where liable to freeze.
- Condensate drains from fan coil units, air handling units, cooling units or any other item or equipment fed with chilled water.
- Chilled water pumps.
- Heating calorifiers, domestic hot water services storage calorifiers and cylinders and plate heat exchangers.
- Chilled water buffer vessels.
- Cold water storage tanks where indicated.
- Rainwater pipes within the building (condensation protection).
- Fresh air intake ductwork.
- Air conditioned and tempered air supply ductwork.
- Discharge ductwork from VAV/constant volume terminal boxes and fan coil units (includes discharge plenum, flexible ducts and diffuser plenum).
- Re-circulation and return air ductwork in plantrooms.
- All external ductwork exposed to weather.
- All external ductwork protected from weather.
- Extract and return air ductwork, where indicated on the drawings, as requiring fire protection or acoustic cladding.

PIPEWORK INSULATION

General

All fittings to be insulated to same standard and finish as adjacent pipework.

All exposed ends of insulation to be sealed with bright Class “O” aluminium foil tape and neatly capped off with suitable aluminium sheet end cap.

For LTHW and HWS systems only, valves and flanges on pipework up to and including 50mm dia. left uninsulated.

2.19 THERMAL INSULATION

LTHW, MTHW, HTHW, Steam, Condensate, HWS, CWS & Hosereels within the Building

LTHW, MTHW, HTHW, Steam Condensate & HWS in Plantrooms within the Building

Insulation & Finish

The insulation and finish shall be one of the following options as specified in **Part 3** of this specification.

Preformed rigid MINERAL FIBRE OR PHENOLIC FOAM plain sections, close fitted and butted together, held in position with a suitable self-adhesive tape or lacing wire, finished and encased with 0.8mm thick Stucco-embossed aluminium sheeting neatly and securely fixed with pop-rivets.

OR

Preformed rigid MINERAL FIBRE OR PHENOLIC FOAM sections, sections close fitted and butted together. The whole enclosed in a layer of 8 oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, finally secured with aluminium bands at 450mm centres.

Valves & Flanges

These shall be insulated as below or as defined in **Part 3** of this specification.

All valves and flanges insulated with purpose-made, easily removable, 0.8mm thick Stucco-embossed aluminium boxes, secured with quick release fasteners. Boxes lined with a mineral fibre mattress or slab of an equivalent thickness and to that of the adjacent pipework insulation, suitably adhered to the internal faces of the box.

OR

Alternatively, on valves and flanges, where specified in **Part 3**, muff covers shall be used which shall be constructed from heavy duty glass cloth with mineral fibre filling and Velcro fixings.

Concealed from View within False Ceilings, Risers etc.

Insulation & Finish

Preformed rigid MINERAL FIBRE OR PHENOLIC FOAM sections, having a factory applied bright Class "O" reinforced aluminium foil facing, sections close fitted and butted together, all longitudinal and circumferential joints sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape, and finally further secured with aluminium bands at 450mm centres.

Valves & Flanges

All valves and flanges insulated and finished as adjacent pipework using oversize sections, all joints and exposed ends sealed with bright Class "O" aluminium foil tape, and finally held in position with two aluminium bands.

Exposed to View within the Building, outside of Plantrooms

Insulation & Finish

Unless otherwise specified in **Part 3** of this specification, preformed rigid mineral fibre or phenolic foam sections, sections close fitted and butted together. The whole enclosed in a layer of 8oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, finally secured with aluminium bands at 450mm centres.

Valves & Flanges

2.19 THERMAL INSULATION

All valves and flanges insulated and finished as adjacent pipework using oversize sections, the whole enclosed in a layer of 8oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, and finally held in position with two aluminium bands.

External to Building

Insulation & Finish

Preformed rigid mineral fibre or phenolic foam sections, having a factory applied bright Class "O" reinforced aluminium foil facing, sections to be close fitted and butted together, all longitudinal and circumferential joints to be sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape, the whole covered with 0.8mm thick polyisobutylene (PIB) sheeting with tensile strength not less than 34 MN/m², with a minimum 50mm overlap, solvent welded on all longitudinal and circumferential joints, and all overlaps must be arranged to shed water and special care taken when sealing joints so as to prevent the ingress of moisture, all to the Manufacturer's recommendations.

Where the insulation is liable to physical damage and so defined in **Part 3** of this specification or on the drawings, it shall be further finished in 0.6mm galvanised sheeting.

Valves & Flanges

All valves and flanges shall be insulated and finished as adjacent pipework using oversize sections, all joints solvent welded, and finally enclosed with a purpose-made, easily removable, 1.0mm thick plain aluminium box, secured with quick release fasteners.

Calorifiers

Calorifiers In Plantrooms within the Building

Insulation

40 kg/m³ density (minimum) 50mm thick Lamella mattress, having a factory applied bright Class "O" reinforced aluminium foil facing, cut on site and close fitted, all joints close butted and sealed using a suitable matching 75mm wide self-adhesive bright Class "O" aluminium foil tape. The whole covered with 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, neatly and securely fixed with self-sealing pop-rivets. All tapping fittings etc., to be left exposed and neatly flanged in. The chest to be fitted with a lined detachable cover of Stucco-embossed aluminium with quick release clips.

Cold Water Storage Cisterns & Condenser Water Cisterns within the Building

In Plantrooms within the Building

Insulation & Finish

The insulation and finish shall be as below or as defined later in **Part 3** of this specification.

45 kg/m³ density (minimum) 50mm thick rigid mineral fibre slabs or 40mm thick, CFC free, phenolic foam slab to sides, ends and top cover, having a factory applied bright Class "O" reinforced aluminium foil facing, cut on site and close fitted to the tank, all longitudinal and circumferential joints close butted and sealed using a matching 75mm wide self-adhesive bright Class "O" aluminium foil tape.

Insulation slabs to be impaled on fasteners, which may be rust-proof metal studs, split prongs, plastic studs or other approved devices fixed securely to the cistern surface. Fasteners finished flush with the surface of insulation and where the foil facing is punctured by the clip or washer, it shall be sealed with a matching self-adhesive bright Class "O" aluminium foil tape. The whole covered with 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, all neatly and securely fixed with self-sealing pop-rivets.

2.19 THERMAL INSULATION

External flanged cisterns with star sectional plates or similar to be infilled with insulation to form flush surface before application of above insulation.

Alternatively, a GRP double skin pre-insulated cistern may be provided.

In External Locations

Insulation & Finish

As specified above but with all joints of the aluminium treated with clear weather-proof mastic (inside the joint not applied after).

Alternatively, a GRP double skin pre-insulated cistern may be provided.

Chilled Water Systems (Also CWS & Hosereels Where Indicated)

Chilled Water in Plantrooms within the Building

Insulation

The insulation shall be either of the following options unless otherwise specified.

Rigid (CFC Free) phenolic foam or preformed rigid mineral fibre sections, having a factory applied bright Class "O" aluminium foil tape, reinforced aluminium foil facing, sections close fitted and butted together, all longitudinal and circumferential joints sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape.

Finish

The finish shall be either of the following options unless otherwise specified later.

The insulation shall be finished and encased with 0.8mm thick Stucco-embossed aluminium sheeting, neatly and securely fixed with Stucco banding or equal approved. Where bends or fittings require to be fixed with rivets, the vapour barrier must be protected with a strip of Class "O" Armaflex tape to absorb penetration.

OR

The whole to be enclosed in a layer of 8oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, and finally secured with aluminium bands at 450mm centres.

NOTE:

A complete and continuous vapour barrier shall be maintained throughout, with particular reference to sealing at pipework supports. Any puncture of the vapour barrier shall be covered and sealed with bright Class "O" self-adhesive aluminium foil tape, prior to the application of any finish.

2.19 THERMAL INSULATION

Valves, Flanges, Strainers & Pump Volutes

All valves, flanges, strainers and pump volutes shall have a layer of 50mm thick flexible 40/45kg/m² Lamella or duct wrap having a bright Class "O" facing and all joints sealed with a suitable matching 75mm wide self-adhesive tape to achieve a complete vapour barrier and finally encased with a purpose-made, easily removable 1.0mm thick Stucco-embossed aluminium box, secured with quick release fastener.

Chilled Water within the Building, Concealed from View within False Ceiling & Risers

Insulation

Rigid (CFC free) PHENOLIC FOAM OR RIGID MINERAL FIBRE section having a factory applied bright Class "O" reinforced aluminium foil facing, sections close fitted and butted together, all longitudinal and circumferential joints sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape, and finally further secured with aluminium bands at 450mm centres.

Valves & Flanges

All valves and flanges insulated and finished as adjacent pipework using oversize sections, all joints and exposed ends sealed with bright Class "O" aluminium foil tape, and finally held in position with two aluminium bands.

Final Connections to Fan Coil Units

Final connections to fan coil units shall be as follows or as specified later in the specification.

19mm thick Class "O" Armaflex sectional insulation, or equal approved, all joints sealed with a suitable adhesive, to ensure a complete vapour seal when being applied to chilled water connections.

Valves, flanges, cocks, unions etc., on chilled water lines only to be insulated with oversize sections as above, with all joints adhered as above.

The above insulation thickness applies to pipework services 15mm to 35mm inclusive only.

Chilled Water within the Building & in View External of Plantrooms

Insulation

The insulation shall be as follows or as specified later in **Part 3** of this specification.

Rigid (CFC free) PHENOLIC FOAM OR RIGID MINERAL FIBRE section having a factory applied bright Class "O" reinforced aluminium foil facing, sections close fitted and butted together, all longitudinal and circumferential joints shall be sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape.

Finish

The whole to be enclosed in a layer of 8oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, and finally secured with aluminium bands at 450mm centres.

Valves & Flanges

All valves and flanges shall be insulated and finished as adjacent pipework using oversize sections, all joints and exposed ends sealed with bright Class "O" aluminium foil tape.

The whole enclosed in a layer of 8oz cotton canvas, neatly applied and treated with two coats of Idenden ET10 solution or equal approved, and finally held in position with two aluminium bands.

Chilled Water External to the Building

2.19 THERMAL INSULATION

Insulation & Finish

Rigid (CFC free) PHENOLIC FOAM OR RIGID MINERAL FIBRE sections, having a factory applied bright Class "O" reinforced aluminium foil facing, sections close fitted and butted together, all longitudinal and circumferential joints shall be sealed using a suitable matching 50mm wide self-adhesive bright Class "O" aluminium foil tape, the whole covered with 0.8mm thick polyisobutylene sheeting with a tensile strength not less than 34 MN/m², with a minimum 50mm overlap, solvent welded on all longitudinal and circumferential joints, and all overlaps must be arranged to shed water and special care taken when sealing joints so as to prevent the ingress of moisture, all to the Manufacturer's recommendations.

Where the insulation is liable to physical damage and so defined in **Part 3** of the specification or on the drawings, it shall be further finished in 0.6m galvanised sheeting.

Valves & Flanges

All valves and flanges insulated and finished as adjacent pipework using oversize sections, all joints solvent welded, and finally enclosed with a purpose-made, easily removable 1.0mm thick plain aluminium box, secured with quick release fasteners.

Trace Heating

Services trace heated by others prior to the application of insulation to chilled water, shall have a complete and continuous vapour barrier shall be maintained throughout, with particular reference to sealing at pipework supports.

Chilled Water Storage Vessels in Plantrooms within the Building

Flat Sided Tanks - Insulation & Finish

45 kg/m³ density (minimum) RIGID MINERAL FIBRE SLABS OR PHENOLIC FOAM (CFC free), having a factory applied bright Class "O" reinforced aluminium foil facing, cut on site and close fitted to the tank, all longitudinal and circumferential joints close butted and sealed using a matching 75mm wide self-adhesive bright Class "O" aluminium foil tape. Insulation slabs to be impaled on fasteners, which may be rust-proof metal studs, split prongs, plastic studs or other approved devices fixed securely to the duct surface. Fasteners suitable for the thickness and weight of the duct slab.

Fasteners finished flush with the surface of insulation and where the foil facing is punctured by the clip or washer, it shall be sealed with a matching self-adhesive bright Class "O" aluminium foil tape. The whole covered with 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, all neatly and securely fixed with self-sealing pop-rivets.

Tanks with star sectional sides to be infilled with insulation to form flush surface before application of above insulation.

To be insulated 60mm thick if mineral wool, 40mm if phenolic foam.

Circular Vessels - Insulation & Thickness

40 kg/m³ density (minimum) Lamella mattress, having a factory applied bright Class "O" reinforced aluminium foil facing, cut on site and close fitted, all joints close butted and sealed using a suitable matching 75mm wide self-adhesive bright Class "O" aluminium foil tape. The whole covered with 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, neatly and securely fixed with self-sealing pop-rivets. All tapping fittings etc., to be left exposed and neatly finished.

Refrigeration Pipework & Chilled Water Below 2°C

2.19 THERMAL INSULATION

Insulation to comprise Class “O” Armaflex. All joints sealed with proprietary adhesive suitable for application and material. 19mm thickness may be used for pipes/coils utilising low temperature water as the secondary cooling system. Where ethylene glycol systems are used, refer to the following table.

Thickness of Insulation Required, Class “O”

Refrigeration -10°C	pipes up to 114mm	19mm
Refrigeration -20°C	pipes up to 114mm	19mm
Refrigeration -30°C	pipes up to 76mm pipes up to 114mm	25mm 32mm
Refrigeration -40°C	pipes up to 28mm pipes up to 48mm all other pipes sizes up to 114mm	25mm 32mm
based on:-	Ambient temperature	= 20°C
	Relative humidity	= 70%
	Giving dew point	= 14.4°C
	Outer surface coefficient of heat transfer	= 9W (m ² K)

These thickness' are based on minimum manufacturing tolerance for engineered wall thickness for Class “O” Armaflex up to 19mm. The nearest commercially available thickness which will prevent condensation has been quoted.

Where sheet material is used for larger pipes, the insulation thickness must be determined individually. In applications where both tubular and sheet material have to be used on pipes (eg. at elbows), the sheet material must be one nominal thickness higher than that of the tubular material, because of the engineered wall thickness of the tubular material.

DUCTWORK INSULATION

Ductwork in Plantrooms Within Building

Insulation

Rectangular ductwork shall be insulated with 45 kg/m³ density (minimum) rigid mineral fibre slabs or 40mm thick phenolic foam (CFC free), or as defined in **Part 3** of this specification, either having a factory applied bright Class “O” reinforced aluminium foil facing. It shall be fixed to the duct with an approved adhesive and the top and bottom pieces shall overlap the sides.

The insulation shall be cut on site and close fitted to the duct, all longitudinal and circumferential joints to be close butted and sealed using a suitable matching 75mm wide self-adhesive bright Class “O” aluminium foil tape.

To prevent sagging and delamination, the undersides of the insulation slab shall be fixed by impaling on fasteners, which may be rust-proof metal studs, split prongs, plastic studs or other approved devices fixed securely to the duct surface. Fastenings shall be suitable for the thickness and weight of the duct slab and shall be spaced at 300mm centres. Fastenings shall be finished flush with the surface of the duct slab and where the foil facing is punctured by the clip or washer, it shall be sealed with a matching self-adhesive bright Class “O” aluminium foil tape. A complete and continuous vapour barrier shall be maintained throughout on supply air ductwork with particular reference to sealing at ductwork supports. Any puncture of the vapour barrier shall be covered and sealed with a bright Class “O” self-adhesive aluminium foil tape.

Finish

As defined later in this specification, the finish shall be either:-

2.19 THERMAL INSULATION

- A covering of 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, all neatly and securely fixed with self-sealing pop rivets. The aluminium cladding to be supported by embedded angle/"u"channel to the insulation slab. The aluminium cladding shall be fixed to the channel to prevent sagging and puncture. The "u" channel to be taped/sealed to form a vapour barrier.
- Canvas finish with 50 x 50mm aluminium angle with smooth surface to be adhered to all corner edges and the whole enclosed in a layer of 8oz cotton canvas, neatly applied and finally treated with two coats of Idenden ET10 solution or equal approved.
- On circular and flat-oval ductwork, the basic insulation shall be minimum 50mm thick 40 kg/m³ density (minimum) Lamella mattress or 25mm thick slotted phenolic foam (CFC free) or as defined in **Part 3** of this specification, either having a factory applied bright Class "O" reinforced aluminium foil facing, secured and finished to one of the alternatives above or as defined later in this specification.

Ductwork Within the Building Concealed from View

Insulation & Finish

Rectangular ductwork shall be insulated with 50mm thick, 45 kg/m³ density (minimum) mineral fibre ductwrap or 25mm thick phenolic foam (CFC free) or as defined in **Part 3** of this specification, either having a factory applied bright Class "O" reinforced aluminium foil facing. It shall be fixed to the duct with an approved adhesive and the top and bottom pieces shall overlap the sides.

The insulation shall be cut on site and close fitted to the duct, all longitudinal and circumferential joints to be close butted and sealed using a suitable matching 100mm wide self-adhesive bright Class "O" aluminium foil tape.

To prevent sagging, the undersides of the insulation shall be fixed by impaling on fasteners, which may be rust-proof metal studs, split prongs, plastic studs or other approved devices fixed securely to the duct surface. Fastenings shall be suitable for the thickness and weight of the duct insulation and shall be spaced at 300mm centres. Fastenings shall be finished flush with the surface of the duct slab and where the foil facing is punctured by the clip or washer, it shall be sealed with a matching self-adhesive bright Class "O" aluminium foil tape. A complete and continuous vapour barrier shall be maintained throughout on supply air ductwork with particular reference to sealing at ductwork supports. Any puncture of the vapour barrier shall be covered and sealed with a bright Class "O" self-adhesive aluminium foil tape.

On circular and flat-oval ductwork, the basic insulation shall be minimum 50mm thick 45 kg/m³ density (minimum) ductwrap mattress or 25mm thick slotted phenolic foam (CFC free) or as defined in **Part 3** of this specification, either having a factory applied bright Class "O" reinforced aluminium foil facing, secured and finished to one of the alternatives above or as defined later in this specification.

Where mineral fibre ductwrap is used, it shall be further secured with 50mm mesh galvanised wire netting applied avoiding puncture of vapour barrier.

Insulated Ductwork External to Building

Rectangular ductwork shall be insulated with 50mm thick, 48 kg/m³ density (minimum) rigid mineral fibre slabs or 25mm thick phenolic foam (CFC free) or as defined in **Part 3** of this specification, either having a factory applied bright Class "O" reinforced aluminium foil facing. It shall be fixed to the duct with an approved adhesive and the top and bottom pieces shall overlap the sides.

The insulation shall be cut on site and close fitted to the duct, all longitudinal and circumferential joints to be close butted and sealed using a suitable matching 75mm wide self-adhesive bright Class "O" aluminium foil tape.

To prevent sagging and delamination, the undersides of the insulation slab shall be fixed by impaling on fasteners, which may be rust-proof metal studs, split prongs, plastic studs or other approved devices fixed securely to the duct surface. Fastenings shall be suitable for the thickness and weight of the duct slab and shall be spaced at 300mm centres. Fastenings shall be finished flush with the surface of the duct slab and where the

2.19 THERMAL INSULATION

foil facing is punctured by the clip or washer, it shall be sealed with a matching self-adhesive bright Class “O” aluminium foil tape. A complete and continuous vapour barrier shall be maintained throughout on supply air ductwork with particular reference to sealing at ductwork supports. Any puncture of the vapour barrier shall be covered and sealed with a bright Class “O” self-adhesive aluminium foil tape.

The whole shall be covered with 1.0mm thick Stucco-embossed aluminium cladding, with a minimum 40mm overlap on all joints, all neatly and securely fixed with self-sealing pop rivets. All overlaps shall be lapped “weatherwise” so as to shed water and all joints are to be sealed with a suitable flexible sealant of like colour to the aluminium cladding.

Aluminium channels as for plantroom ductwork shall be used to support the cladding. Drill holes to be sealed against the weather with a suitable mastic for application and external use.

On circular and flat-oval ductwork, the basic insulation shall be minimum 50mm thick 40 kg/m³ density (minimum) LAMELLA MATTRESS OR 25mm THICK SLOTTED PHENOLIC FOAM (CFC free) or as defined in Part 3 of this specification, either having a factory applied bright Class “O” reinforced aluminium foil facing, secured and finished to one of the alternatives above or as defined later in this specification.

As an alternative to the above, the whole may be covered No. 10 glasscloth in lieu of aluminium cladding. All joints to be overlapped 50mm minimum and the whole painted a minimum two coat or weather-proofing PVA as ET150 or approved, to prevent the ingress of moisture and to shed water. All corners and edges to incorporate suitable reinforced corner angles, prior to the application of the sheeting, to give a neat appearance, with the sheeting being firmly and continuously adhered to the insulation slabs.

On any of the above combinations, the insulation and finish on the tops of all ducts to be pitched to allow water run-off (to approval) and, in particular, without creating a void between the insulation slab and the finishing sheeting.

The insulation and finish on the underneath edges of ductwork to incorporate reinforced corners to provide drip edge, to prevent rainwater tracking across the underneath surface of the finished insulation.

Intermediate supports to be provided on the underside of ducts to prevent sagging.

Test holes in ductwork shall be weather-proof, and where ductwork services pass through any type of structure, insulating flashing shall be incorporated to an approved standard.

Ductwork bracketry external to the building will incorporate wood blocks by Ductwork Installer and an aluminium sleeve shall be provided to extend 100mm either side of bracket.

Ductwork Insulation - Generally

Fixing methods of duct insulation shall provide a minimum of direct metal paths which thermally bridge the insulation, particularly when the insulation is metal faces. The full insulating effect shall be maintained at connections and access openings and panels including the edges of such openings. Thermal insulation shall cover all forms of flanges joints, fasteners and stiffeners either by means of purpose-made boxes or by increasing the general thickness of the insulation to give at least 6mm cover. Where insulation is applied in layers, all joints in all layers shall be staggered.

At all points of support, the insulation and outer covering and vapour seal shall be continuous and shall not be pierced or fouled by the supports. The insulation at supports shall be material of sufficient compressive strength to take the loads transmitted to the supports.

Preformed slab insulation shall be applied with adjacent sides lapped to maintain a uniform thickness at corners.

All ductwork flanges and stiffeners shall be insulated and vapour sealed at working temperatures below ambient.

In plantroom access panels, test holes etc., shall be left uninsulated but the access panels shall be fitted with easily detachable insulation covers specially made and neatly fitted.

2.19 THERMAL INSULATION

Thermal insulation shall be applied to ductwork, fans, heater and cooler casings etc., carrying conditioned air in plantrooms and to ductwork (including recalculation air ductwork) carrying warmed or chilled air through unconditioned spaces or the open air. Unless otherwise indicated, ductwork carrying warmed or chilled air through conditioned spaces shall not be insulated.

Thermal insulation applied to the inside of the ductwork to ductwork in underground or windowless buildings and elsewhere as indicated shall either be entirely non-combustible (BS.476:Section 1) or be of non-combustible material faced with combustible material not more than 0.8mm thick and complying with the flame spread requirements of BS.476:Section 2:Class 1.

Thermal insulation on ductwork etc. inside buildings generally shall be in accordance with BS 5422.

Insulation shall cover ductwork flanges by at least 6m.

For ductwork carrying chilled air the insulation shall cover the flanges.

For ductwork carrying chilled air of a temperature lower than the maximum design ambient dew point temperature, and where specified in **Part 3**, the outer surface of the thermal insulation shall be protected by a continuous water vapour barrier having a permeance not exceeding 57.2ug/Ns. The vapour barrier and the insulation shall not be pierced or damaged by supports; load distributing sleeves shall be provided where necessary. At discontinuities and the ends of sections, the vapour barrier shall be returned to the ductwork to prevent moisture from entering the insulation at the edges.

Where thermal insulation is fixed to the inside of the ductwork, the surface of the insulation exposed to the air flow shall be proof against shredding and erosion; such insulation adjacent to humidifiers and cooling coils shall also have the surface exposed to the air flow protected against water (to prevent the insulation from becoming waterlogged).

Thermal insulation shall be securely fixed to the ductwork. Adhesives shall be non-flammable and compatible with the insulation. In no circumstances shall an adhesive or solvent which attacks or dissolves the ductwork or the insulation be used.

Insulation of ductwork supports (installed by Ductwork Installer) shall be to HVCA DW/142 and shall comprise wood blocks or suitable approved dense insulation material.

2.19 THERMAL INSULATION

**TABLE 1
SCHEDULE OF INSULATION**

Insulation thickness shall be as follows unless otherwise defined in **Part 3** of this specification.

Insulation thickness, excluding finishing material, shall be in accordance with the following Table - based on thermal conductivity values 0.04W/m°C mineral fibre and 0.02W/m°C phenolic foam at 20°C.

THICKNESS OF INSULATION								
Pipe Size	Internal CWS/DWS /MWS Anti-Condensation		CHW & Cooling Water		LTHW/Condensate 85°C max		MTHW 85°C - 120°C	
	Mineral Fibre	Phenolic Foam	Mineral Fibre	Phenolic Foam	Mineral Fibre	Phenolic Foam	Glass Fibre	Phenolic Foam
15	20	15	25	15	25	20	25	N/A
20	20	15	25	15	25	20	30	N/A
25	20	15	30	15	25	20	30	N/A
32	20	15	30	20	25	20	30	N/A
40	25	15	30	20	25	20	30	N/A
50	25	15	30	20	30	25	40	N/A
65	25	15	40	20	30	25	40	N/A
80	25	15	40	20	30	25	40	N/A
100	30	20	40	20	30	25	40	N/A
125	30	20	50	25	40	25	40	N/A
150	30	20	50	25	40	25	40	N/A
>150	40	20	50	25	40	25	40	N/A
+ Flat	50	25	60	40	50	25	50	N/A

THICKNESS OF INSULATION						
Pipe Size	HTHW/Steam above 120°C		HWS up to 70°C		Anti-Frost External Services *	
	Mineral Fibre	Phenolic Foam	Mineral Fibre	Phenolic Foam	Mineral Fibre	Phenolic Foam
15	40	N/A	25	20	80	40
20	40	N/A	30	20	80	40
25	40	N/A	30	25	80	40
32	50	N/A	30	25	80	40
40	50	N/A	30	25	80	40
50	50	N/A	30	25	30	20
65	50	N/A	40	30	30	20
80	50	N/A	40	30	30	20
100	50	N/A	40	30	30	20
125	60	N/A	40	30	30	20
150	60	N/A	40	30	30	20
>150	60	N/A	40	35	30	20
+ Flat	75	N/A	50	35	30	20

Ductwork: All Sizes - Mineral Fibre = 50mm thick.

Phenolic Foam = 25mm thick (40mm where aluminium clad or weather-proofed). All Sizes - Mineral Fibre = 50mm thick.

* These anti-frost minimum thickness' are to minimise the possibility of water freezing, but note:-

- Pipe sizes below 40mm will require trace heating as well as insulation.
- On larger pipes above 65mm, normal thickness of insulation may be needed for heat loss/heat gain reasons. (See **Part 3** specification)

2.19 THERMAL INSULATION

INSULATION REQUIREMENTS

The following services require insulation: Hot and cold water services, Heating pipe work, and Refrigeration pipe work.

Insulation is to be installed on all boiler house pipe work, plant room pipe work, vertical risers, ceiling voids, roof spaces, under floors, and boxed in compartments.

Pipe work is to be insulated with foil clad phenolic form (Kingspan).

15 – 65mm.dia – 19mm phenolic form

80 – 150mm dia - 25mm phenolic form

All pipe work dia – within roof spaces - 40mm phenolic form

Where insulation is visible, i.e. plant rooms, roof spaces or within occupied spaces (except as detailed below). It shall be further protected with isogenopac cladding.

Hot and cold water surface pipe work within kitchens, toilets, and utility area do not require to be insulated.

Exposed heating pipe work within occupied spaces do not require to be insulated

2.20 COLOUR CODING FOR BUILDING SERVICES

IDENTIFICATION OF PIPEWORK

Pipework services shall be identified in accordance with BS 1710 using coloured plastic adhesive identification bands incorporating direction of flow arrows and appropriate abbreviation of the particular service. Basic colours may be painted over whole length of pipe. Colours for paints shall be to BS 5252 and BS 4800.

COLOUR CODING

The colour coding shall have the basic colour identifying the general contents and also the safety colour identifying the exact contents, temperature, quality or presence of additional substances to the basic content.

Basic Colour

To be applied to the whole system or confined to basic colour bands at all valves, junctions, service appliances, structural penetrations, access openings to ducts and voids, and at intervals not greater than 3m throughout the pipework installation.

Where basic colour bands are used, they are to be placed on each side of the code colour and have a minimum band width of 75mm for diameters up to 50mm and 150mm width for diameters above 50mm.

Code for Safety Colours

To have a minimum band width of 100mm with symbols, words and letters indicating the contents, function, pipe diameter and direction of flow (➡) printed in black on or adjacent to the colour code as shown in the Colour Identification Charts with lettering not less than 10mm in height when applied to diameters less than 50mm and not less than 38mm when applied to diameters greater than 50mm.

Key for Basic Colour Codes

Each colour is represented by a letter or letters in accordance with the following Tables:-

BASIC COLOURS			
Colour	Key	BS 5252 Colour Ref.	Basic Contents
Green	G	12 D 45	Water
Silver Grey	SGy	10 A 03	Steam
Brown	B	06 C 39	Oil
Yellow Ochra	YO	08 C 35	Gases
Black	BK	Black	Drainage
Light Blue	LBe	20 E 51	Air also Vacuum
Violet	V	22 C 37	Acids & Alkalis
Orange	O	06 E 51	Electrical Conduits

2.20 COLOUR CODING FOR BUILDING SERVICES

CODE COLOURS			
Colour	Key	BS 5252 Colour Ref.	
Auxiliary Blue	ABe	18 E 53	
Crimson	C	04 D 45	
Emerald Green	EG	14 E 53	
Salmon Pink	SPk	04 C 33	
Safety Red	SR	04 E 53	
French Blue	FBe	20 D 45	
Grey	Gy	00 A 09	Exhaust/Recirculated Air
Primrose	P	12 E 51	
Terracotta/Brown	T	06 C 39	
Yellow	Yw	10 E 53	
White	W	White	
Black	BK	Black	
Maroon	M	02 C 39	

COLOUR IDENTIFICATION CHARTS

General Services

Pipe Contents	Basic Colour approx. 150mm	Colour Code Indication 100mm			Basic Colour approx. 150mm
WATER:					
Drinking	G	ABe			G
Cooling	G	W			G
Boiling Feed	G	C	W	C	G
Condensate	G	C	EG	C	G
Condenser	G	EG			G
Chilled	G	W	EG	W	G
Central Heating -100°C	G	ABe	C	ABe	G
Central Heating +100°C	G	C	ABe	C	G
Cold, Down Service	G	W	ABe	W	G
Hot Water Supply	G	W	C	W	G
Hydraulic Power	G	SPk			G
Sea, River Untreated	G				
Fire Extinguishing	G	SR			G
Laundry, Softened	G (SOFTENED)				
Laundry, Raw	G (RAW)				
Laundry, Recovered	G (RECOVERED)				
Steam	SGy				
Drainage	Bk				
Electrical Conduit Ducts	O				

2.20 COLOUR CODING FOR BUILDING SERVICES

Pipe Contents	Basic Colour approx. 150mm	Colour Code Indication 100mm	Basic Colour approx. 150mm
TOWN GAS:			
Natural Gas	YO	Yw	YO
INDUSTRIAL GASES:			
Vacuum	LBe	W	LBe
Acetylene *	YO	M (ACETYLENE)	YO
Argon		YO (ARGON)	
Butane		YO (BUTANE)	
Hydrogen		YO (HYDROGEN)	
Nitrogen		YO (NITROGEN)	
Oxygen		YO (INDUSTRIAL OXYGEN)	
Propane		YO (PROPANE)	
Refrigerant		YO (REFRIGERANT)	
MEDICAL GASES:			
Compressed Air	LBe	W	Bk
Vacuum	LBe	P	LBe
Nitrous Oxide	YO	FBe	YO
Oxygen	YO	W	YO
Nitrous Oxide Oxygen Mixture	YO	FBe	W
Spare Medical Gas		YO (SPARE MEDICAL GAS)	
Pathology services shall have an extra code band (terracotta) with the letters "PATH" or "PATHOLOGY" clearly printed in black as illustrated in the example given below.			
Example:	Basic Colour (PATHOLOGY)	T	Code Colour
			Basic Colour
* Acetylene pipelines shall have identification (as shown) at intervals not greater than 3m.			

Oils, Acids, Alkalis & Chemicals

Pipe Contents	Basic Colour approx. 150mm	Colour Code Indication 100mm	Basic Colour approx. 150mm
OILS:			
Burner Fuel		B	
Diesel	B	W	B
Hydraulic Power	B	SPk	B
Lubricating	B	EG	B
Transformer	B	C	B
Liquid Soap (Laundries)		B (SOAP)	
ACIDS, ALKALIS & CHEMICALS:			
Bleach		V (BLEACH)	
Caustic Soda		V (CAUSTIC SODA)	
Cleaning Fluid		V (CLEANING FLUID)	
Soda		V (SODA)	

2.20 COLOUR CODING FOR BUILDING SERVICES

Ventilation, Plant & Ductwork

Shall be identified in accordance with DW/144 coded and fixed as specified in **Part 3** of this specification. **“In addition the basic identification, it shall be included at junctions, bulkheads and wall penetrations.**

Terminals, Air Handling Plant & Plantrooms

Shall be clearly and durably labelled and the system and its identification code displayed in all plantrooms.

Dampers

Shall be clearly and durably labelled. Fire dampers shall be marked each side and their labels shall include the words “FIRE DAMPER” in red letters on white background.

LABELLING REQUIREMENTS

38mm dia, traffolyte valve tags, are to be installed on all valves, except on local isolation valves. They are to be engraved with a number and an abbreviated service description, or a specific service name, as detailed by the **S.O.** The tags are to be secured with brass beaded link chain with a locking link.

All mechanical plant installed is to be labelled, indicating its purpose; its location and what it serves.

A framed A4 / encapsulated A3 valve chart and schematic line diagram is to be displayed within the plant room and any service shaft on each floor. The charts and drawings are to be securely fixed by the MSC.

A framed A4 / encapsulated A3 gas line diagram is to be provided. The charts and drawings are to be securely fixed by the MSC.

Valve charts and schematic line diagrams are to be included within the O & M manuals.

All new pipe work and ductwork is to be labelled and colour banded in accordance with BS 1710: 1984

“The basic identification shall be included at junctions, at both sides of each valve, service appliance, bulkhead and wall penetration and at any other place where identification is necessary”.

Traffolyte labels are to be fitted, on / adjacent to all control panels, panic buttons, safety isolation valves and main items of plant, in accordance with CA requirements.

2.21 COLD WATER STORAGE VESSELS

GENERAL

Storage vessels shall be one of the following or other alternatives as defined in **Part 3** of this specification.

The selection of storage cylinders shall be limited to those listed in the WRC Water Fittings and Materials Directory.

The Water Supply Bye-Laws and any specific requirements of the Local Water Supply Undertaking shall apply to the manufacture of storage vessels, fittings and the installation of the vessels, fittings and the water distribution systems as a whole.

Feed and storage cisterns are included in this section.

Where coupled or multi-sectioned cisterns are installed, they shall be coupled in series to minimise stagnation.

TYPES

Definitions

Feed Cisterns

Any storage cistern for supplying cold water to a cooling or hot water apparatus cylinder or tank.

Storage Cistern

Any cistern other than a flushing cistern, having a free water surface under atmospheric pressure, but does not include a drinking trough or drinking bowl for animals including poultry.

Cylinder

A closed vessel capable of containing water under pressure greater than atmospheric pressure.

Tank

A non-cylindrical closed vessel capable of containing water under greater pressure than atmospheric pressure. (Measures should be taken to avoid stratification in large water storage tanks.)

Feed & Storage Cisterns

These shall be treated as being for the storage of potable water and be of the following types as specified in **Part 3** or other alternatives as defined in **Part 3**:-

- Galvanised mild steel to BS 417:Part 2:1987 of the Grade "A" thickness.
- Pressed steel sectional to BS 1564.
- Glass reinforced plastic (GRP) moulded sectional or one piece which have been approved by the "UK" Water Fitting Bye-Laws Scheme.
- Thermoplastic - moulded in 1-piece to BS 4213:1991. When used as expansion cisterns in association with hot water heating apparatus, the compound used to manufacture cisterns to have a VICAT softening point of not less than 110°C.

2.21 COLD WATER STORAGE VESSELS

COVERS

These shall be of the same materials as the cistern or, for ferrous cisterns, galvanised mild steel or other compatible material and of the thickness specified in the BS or when access to the top of the cistern is required be suitable to accept 2 x 80kg loads applied 0.5m apart in any position on the cover.

They shall be watertight and securely fixed with overlapping edges on the cisterns supplying potable and domestic water systems and:-

- fitted with vents screened with stainless steel mesh of maximum aperture size 0.65mm.
- supplied with a personnel access manhole not less than 500mm clear height over. The manhole to be provided with an upstand to prevent the ingress of foreign matter, and be fitted with a cover gasketed and bolted in to place.
- supplied with a minimum access above of 350mm clear height over and a 300mm x 300mm access point with bolted and sealed cover directly over the ball valve to facilitate maintenance. Unless the ball valve is located in a chamber higher than the cistern cover, the access point to have a suitable upstand.
- designed to be flat for all cisterns installed internally and cambered for those installed externally.
- provided with flanged connections for open vents.

Covers shall be loose on systems supplying closed systems, eg. space heating, and be:-

- of galvanised steel as specified in BS 417 or plastic as specified in BS 4213:1991.
- provided with suitable close fitting holes to receive open vents, which do not inhibit the removal of the covers.

CONNECTIONS

These shall include sampling points to check water quality and be made using materials selected to avoid electrolytic action.

On mild steel cisterns to be as BS 1564. Connections 50mm and over to be pads which suit flanges to BS 4504. Connections under 50mm being by tapped sockets.

Connections shall have thermometers to indicate inlet and outlet temperatures.

On GRP or thermoplastic cisterns connections to be factory fitted studded flange pads to BS 4504:Part 1:1969 for those over 50mm. Connections 50mm and below may be made by cutting on site and using backnuts and plastic washers.

SUPPORT & ERECTION

Sectional cisterns shall be externally flanged unless otherwise specified in **Part 3** and erected to the Manufacturer's recommendations using a non-toxic jointing material.

They shall be supported in accordance with the Manufacturer's recommendations on a steelwork frame or masonry piers capped with 75mm x 75mm steel tees, toe down and positioned so that access is available to each nut and bolt.

Plastic moulded 1-piece cisterns shall be fully supported over their base as specified in BS 4213.

Galvanised mild steel cisterns shall be supported on a mild steel frame or support members.

2.21 COLD WATER STORAGE VESSELS

WATER INLETS

These shall incorporate a service valve and discharge into the cistern at the height above the overflow as specified in **Part 3**.

The cistern fill level shall not be less than 25mm below the overflow level of the cistern. There shall be a Type B air gap between the overflow level and the inlet to the cistern of an adequate dimension unless specified in **Part 3**.

OPEN VENT PIPES

These shall, if from a secondary system, not discharge into a primary feed and expansion system and vice versa.

They shall be terminated a minimum of 25mm above the water inlet fill level.

OVERFLOWS & WARNING PIPES

These shall be fitted in accordance with Water Supply Bye-Laws.

They shall be of corrosion resisting material, turned down in the cistern and terminated 50mm below the water line and not rise in level outside the cistern.

On water supply cisterns, there shall be within the plantroom pipe, a stainless steel mesh screen having a maximum aperture of 0.65mm and minimum free area equal to the area of the pipe.

They shall discharge outside buildings in a conspicuous position in the case of warning pipes.

DRAINS

These shall be taken from the lowest point of the cistern and on each cistern comprise a valved drain connection of the size indicated in **Part 3** discharging into a suitable gully (incorporating an air gap between the outlet of the drain pipe and the gully trap).

TESTING OF CISTERNS

After erection, each cistern shall be filled with water and allowed to stand for 1 hour before being inspected for leaks. Any leaks found shall be rectified.

INTERNAL & EXTERNAL TREATMENT

Ferrous cisterns to be thoroughly cleaned and treated internally with epoxy resin or bituminous solution approved by the Water Authority before delivery to site. After erection and testing a further 2 No. coats are to be applied internally.

Cisterns which are to be used as part of a potable water supply installation, to have internally applied treatment to BS 3416:1975 Type II, manufactured from petroleum or asphalt bitumen or other approved non-toxic coatings. Coal tar bitumen is excluded for these purposes.

Non-galvanised ferrous cisterns to be treated externally with 2 No. coats of an epoxy resin or bituminous solution applied in accordance with the Manufacturer's recommendations.

INSULATION

Insulation shall be applied to the cisterns as specified in the "Thermal Insulation" section of this specification.

2.21 COLD WATER STORAGE VESSELS

DRIP TRAYS

These shall be either galvanised steel or reinforced glass fibre to the relevant British Standard and provided with a drain at the lowest point which is to be piped to a suitable gully.

BALL FLOAT VALVES

These shall be fitted to each cistern to prevent overflow, be of copper alloy construction of the following types as specified in **Part 3**:-

- Diaphragm type to BS 1212:Part 2:1990 Kite-marked on sizes 15m and 22m.
- Piston type to BS 1212:Part 1:1990 with non-return valve on inlet on sizes 28mm to 42mm.

They shall comprise copper floats to BS 1968:1953 or plastic floats to BS 2456:1990 for cold water cisterns only and be capable of providing tight shut-off against the appropriate test pressure specified in BS 1212 and comply with the requirement to prevent a Class 2 risk.

GLASS REINFORCED PLASTIC (GRP)

Rectangular storage cistern manufactured from glass reinforced plastic panels shall be made by the hot press moulding process. Assembly of tank panels shall be by means of galvanised bolts unless in contact with the water in which case they shall be of stainless steel. Panels shall be assembled using a non-toxic butyl rubber compound covering the full width of the panel flange.

The cistern sides and ends shall be either internally stayed using stainless steel components or externally corseted using galvanised rolled steel sections.

Where a cistern is divided into two compartments, a full height partition shall be constructed from standard panels and be capable of working normally with one side empty. Each compartment to have provision for access and air vents.

Cisterns shall be externally flanged or externally flanged sides with internally flanged base as indicated on the drawings and specified in **Part 3**; with supporting bearers or flat base provided by others in accordance with Cistern Manufacturer's requirements.

Cisterns in excess of 1.5m in depth shall be fitted with internal GRP ladder and galvanised steel external access ladder.

Pipework connections shall be by means of pads bonded to the inside and/or outside of the cistern panel, complete with bolts or studs as required. Small diameter connections may be made using commercially available components.

The cistern shall be fitted with heavy duty cover to exclude dust and moisture and fitted with access manhole, float valve maintenance access and screened air vent. Access/maintenance manholes shall be fitted with key operated locking device to prevent unauthorised entry. Where required, an enclosed float valve chamber incorporating access facility shall be provided; constructed to withstand stresses imposed by the float valve when opening and closing, and in the fully open and closed position.

A sleeved entry shall be provided in the cistern cover to accommodate the expansion pipework from the domestic hot water service calorifier.

A cat and mouse or hydrostatic pressure operated gauge shall be fitted to the cistern recording in litres the amount of water stored.

2.21 COLD WATER STORAGE VESSELS

On completion of the installation the cistern shall be filled to its maximum operating volume and examined for leakage.

A label shall be fixed to the installation on completion quoting Manufacturer's name and address, date of installation, volume and reference number.

Cisterns installed externally shall be effectively insulated against frost with base, sides and roof pre-insulated by means of encapsulating a polyurethane foam (at 0.8m²/°C minimum) within a cavity between an outer UV stabilised skin and the double cistern panel. Holes cut through the skin and insulation for pipework connections shall be vapour sealed with a weather-proof recessed shrouding from the outer surface of the insulation skin to the tank panel.

Cisterns installed internally may be insulated as described for external units or alternatively insulated after erection and testing using a slab insulating material attached to the panel surface and vapour sealed (refer to "Thermal Insulation" section of this specification).

UPR (UNSATURATED POLYESTER RESIN)

One piece or split moulding rectangular storage cisterns complying with Water Bye-Law 30 requirements, shall be manufactured from unsaturated polyester resin reinforced with glass fibre in accordance with BS 7491. The cistern shall be complete with a close fitting secured lid with gasket, access hatch to float valve location, screened air vent, screened warning/overflow unit, and sleeved entry for domestic hot water expansion pipe. Access hatch to be provided with key operated locking device to prevent unauthorised entry.

Connections for water services shall be made in accordance with Manufacturer's instructions using standard type hole saws for perforations and commercially available tank connections.

Cistern walls and lid shall incorporate encapsulated insulation of 50mm and 25mm thickness for external and internal installation respectively. In the event that insulation encapsulation is perforated when making connections, a vapour sealed and weather-proof shrouding shall be provided and fitted.

Cisterns shall be supported on a flat level base, provided by others, in accordance with Manufacturer's requirements.

Cisterns for potable water storage shall be Class A, while those for non-potable storage purposes may be Class B.

Cisterns shall be clearly and durably marked with the Manufacturer's name or trade mark and the cistern designation, and installation instructions.

STEEL

Rectangular storage cistern shall be manufactured from galvanised mild steel hot pressed Type 1 plates with all necessary stays and cleats in accordance with BS 1564 - Pressed Steel Sectional Rectangular Tanks. Assembly of the cistern panels shall be by means of galvanised bolts in an approved non-toxic insoluble strip jointing.

The sides and ends shall be externally flanged with either internally or externally flanged base commensurate with intended supporting arrangements. Supporting bearers or flat base shall be provided by others in accordance with Manufacturer's requirements to suit cistern construction.

Where a cistern is divided into two compartments, a full height partition shall be constructed from standard plates and be capable of working normally with one side empty. Each compartment to have provision for access and air vents.

Cisterns in excess of 1.5m in depth shall be fitted with internal and external galvanised mild steel access ladders.

2.21 COLD WATER STORAGE VESSELS

Connections shall be by means of pads, tapped bosses, screwed flanges or sockets commensurate with size of pipework.

The cistern shall be provided with a cover constructed from mild steel plates to exclude all dust and moisture, of flat or cambered/pitched construction for internal or external location respectively. Hinged access/maintenance manholes with key operated locking device shall be provided as necessary. Where required, a raised and enclosed float valve housing shall be incorporated.

A cat and mouse or dial gauge shall be fitted to the cistern, or each compartment, recording in litres the amount of water stored.

On completion of cistern and cover erection, an approved non-toxic insoluble coating shall be applied internally and allowed to dry before testing by filling with clean water is carried out.

Cisterns shall be legibly and permanently marked with the Manufacturer's name or trade mark, address, date of installation, BS number and volume.

Cisterns shall be insulated as appropriate to fixing location (refer to "Thermal Insulation" section of this specification).

DOMESTIC STORAGE CISTERNS

Storage cisterns for installation in domestic dwellings shall comply with BS 4213 - Cold Water Storage and Feed and Expansion Cisterns and Lids - and comply with Water Bye-Law 30 requirements. Cisterns and lids shall be clearly and durably marked with the Manufacturer's name or trade mark, BS type reference, and the number and date of the British Standard.

The cistern shall be fully supported on a durable, rigid, flat and level base provided by others; connections shall be cleanly drilled with a hole cutter and made with commercially available cistern connectors and internally and externally fitted support washers. The float operated valve shall be fitted in conjunction with the backing plate providing reinforcement to cistern walls. Pipework connected to the cistern shall be supported and aligned so as not to distort the cistern.

Cisterns and lids shall be provided with loose fitting insulating blanket enclosed in a plastic material and secured in position with plastic strapping.

2.22 HOT WATER SERVICE CYLINDERS

As specified in the schedules and **Part 3** of this specification and shown on the drawings.

VENTED HOT WATER CALORIFIER

Vertical pattern hot water storage calorifier of solid copper or galvanised steel construction, as specified in **Part 3** specification, in accordance with BS 853 with all necessary piping connections and heater battery to provide 2-hour heat up period based upon primary flow and return temperatures. The calorifier shall be provided with convex bottom and legs.

The design of the calorifier is to permit raising the content to 70°C when isolated from secondary flow and return circuits for purpose of pasteurising to minimise risk of Legionella Pneumophila multiplying.

The calorifier shall be suitable for a system operating pressure and tested on completion at Manufacturer's works to not less than 1½ times this working pressure.

The calorifier shall be provided uninsulated for subsequent on-site insulation by Specialist Contractor.

OR

Pre-insulated comprising 50mm glass wool mattress and clad with 0.8mm thick Stucco-embossed aluminium cladding, 40mm minimum overlap on all joints, neatly and securely fixed with self-sealing pop rivets. All tapping fittings etc., to be left exposed and neatly flanged in. The battery and access manhole to be fitted with a lined detachable cover and quick release clips (as defined in **Part 3**).

Alternatively, the calorifier where specified later may be copper lined mild steel construction in accordance with BS 853.

UNVENTED HOT WATER CALORIFIER

Indirect vertical pattern unvented hot water storage calorifier of solid copper construction in accordance with BS 853, supplied as a unit or package and complete with all necessary controls, safety devices, and expansion vessel, in compliance with Building Regulations (G3). The heater battery to provide 2-hour heat up period minimum based upon primary flow and return temperatures. The calorifier shall be provided with convex bottom and legs.

The design of the calorifier is to permit raising the contents to 70°C when isolated from secondary flow and return circuits for purposes of pasteurising to minimise risk of Legionella Pneumophila multiplying.

The calorifier shall be suitable for the system operating pressure and tested on completion at Manufacturer's works to not less than 1½ times this working pressure.

The calorifier shall be provided uninsulated for subsequent on-site insulation by Specialist Contractor.

OR

Pre-insulated comprising 50mm glass wool mattress and clad with 0.8mm thick Stucco-embossed aluminium cladding, 40mm minimum overlap on all joints, neatly and securely fixed with self-sealing pop rivets. All tapping fittings etc., to be left exposed and neatly flanged in. The battery and access manhole to be fitted with a lined detachable cover and quick release clips (as defined in **Part 3**).

Alternatively, the calorifier where specified later may be copper lined mild steel construction in accordance with BS 853.

2.22 HOT WATER SERVICE CYLINDERS

VENTED DOMESTIC HOT WATER CYLINDER

Copper direct cylinder manufactured in accordance with BS 699, and being suitable for a maximum working head system as specified in the Schedules.

A G2¼ thread boss shall be provided for fitting as side entry (top entry) immersion heater.

Aluminium protector rod shall be fitted internally near the cylinder base.

The cylinder shall be supplied with factory applied insulation having a head loss not exceeding 1 W/litre capacity.

Alternatively, if specified, it may be a copper double feed indirect cylinder manufactured in accordance with BS 1566.

UNVENTED DOMESTIC HOT WATER CYLINDER

Purpose designed "high pressure" direct (indirect) copper cylinder for unvented installation complete with all necessary control and safety valves, thermostatic control and non-resetting thermal cut-out, all in compliance with Building Regulation G3, supplied as package.

One/two immersion heater/s shall be fitted to the unit (direct pattern only) as specified.

Aluminium anodes shall be fitted internally.

Cylinders shall be supplied with factory applied insulation having steel cased finish.

Alternatively, where specified, it may be a high pressure unvented direct (indirect) hot water storage cylinder of polyethylene bonded polythene lined steel with all necessary control and safety valves, thermostatic control and non-resetting thermal cut-out, all in compliance with Building Regulation G3, supplied as a package or unit.

PLATE HEAT EXCHANGERS

The construction and materials shall be appropriate to the duty conditions. Unless specified to the contrary elsewhere, the plates shall be stainless steel and the gaskets synthetic rubber.

The complete unit shall be pressure rated at a minimum pressure of 5 Bar or twice the maximum working pressure, whichever is the higher.

The plates are to be contained in a frame arranged with free space to allow easy opening of the plates for inspection and cleaning. The frames shall also be able to allow further plates to be added in the future.

Covers to be provided to prevent the ingress of dirt at the edges and the exchanger is to be thermally insulated to the same standard as other plantroom heated surfaces unless otherwise specified.

2.23 DOMESTIC HOT WATER HEATERS

GAS FIRED WATER HEATER

Water heaters shall be of a type approved by British Gas and listed within the Water Fittings and Materials Directory.

They shall be of the glass lined gas fired direct type, fitted with atmospheric burner for 2nd family gas. The storage vessel shall be suitable for a maximum working pressure of 10.3 bar and incorporation into conventional vented hot water supply systems or for direct on mains installation.

They shall be equipped with an automatic gas shut off device to shut off the entire gas supply in the event of excessive temperature in the storage vessel and pilot safety shut off.

A replaceable magnesium anode for additional internal protection of the storage vessel shall be fitted.

The primary flue shall terminate with draught diverter or hood to receive the secondary flue pipe installation terminating externally.

The storage vessel shall be insulated with vermin proof glass fibre insulation or equal, encased in an outer jacket having baked enamel finish.

Operation of the heater shall be by means of electric time clock control.

When used as a direct on mains unvented system, it shall be fitted with an “unvented kit” comprising:-

- Non-return valve.
- Line strainer.
- Pressure limiting valve.
- Thermal and pressure relief valve (factory fitted).
- Expansion relief.
- Expansion vessel.

ELECTRIC HOT WATER HEATERS

The size, capacity and duty of the hot water heater shall be as specified in **Part 3** and the Schedules.

The thermal insulation forming part of the unit shall be CFC free with a heat loss not greater than 1 Watt/litre of stored water at 60°C.

Heating units shall be copper sheathed embedded rod type elements controlled by stem type adjustable 40-80°C thermostats.

The water container shall be copper construction tested to 0.5 Bar.

The outer casing shall be corrosion proof steel with white enamel finish.

The float valve shall be to BS 1212:Part 3 medium pressure.

2.24 WATER SOFTENERS

BASE EXCHANGE UNITS

Base exchange units shall be provided where specified in **Part 3**.

The hot and cold water softening installation shall have single resin shell manufactured from glass reinforced plastic and fitted with non-corrodible internals. A separate brine measure and salt tank shall be provided. The installation shall be complete with all ancillary controls for fully automatic operation to permit regeneration to occur at predetermined intervals of up to 7 days and a pre-set time within a 24 hour period. An additional facility shall permit an extra regeneration sequence to be initiated manually.

Alternatively, the cold water softening installation shall have duplex resin shells manufactured from glass reinforced plastic and fitted with non-corrodible internals. A separate brine measure and salt tank shall be provided. The installation shall be complete with ancillary controls for fully automatic operation to permit regeneration to occur at variable intervals depending upon quantity of treated water since previous regeneration and with a facility for maintaining an uninterrupted supply of softened water. An additional facility shall permit an extra generation sequence of either or both resin shells to be initiated manually. The particular alternative shall be as defined in **Part 3** and the schedules.

A pre-wired and tested control panel shall be wall mounted remote from the softener assembly. The panel shall incorporate but not be limited to mimic display with indicating lights, hinged fascia to provide quick and easy access to controls for changes to be made, facilities for remote fault and alarm conditions, and constructed in accordance with IP54 and BS EN 60529.

BASE EXCHANGE FOR DOMESTIC PURPOSES

Self-contained automatic cold water softening unit shall be of a type listed in WRC Water Fittings and Materials Directory for connection to incoming mains water supply. Regeneration shall be controlled by means of a valve control unit initiating the process on a timed basis. Facility for initiating extra regeneration manually shall be incorporated.

Alternatively, regeneration shall be controlled electronically by monitoring the quantity of water softened since the last regeneration and the need for further generation within the following 24 hours based upon usage pattern where specified in **Part 3**.

On completion of the installation and connection to electrical and water supplies, a check shall be carried out for correctness of installation and compliance with Water Bye-Laws, before the equipment is formally commissioned in accordance with Manufacturer's instructions and left in working condition.

Provide and leave with the installation the necessary instruction manual and water hardness test kit for use by the Occupier, together with a supply of salt sufficient for two generation sequences.

ELECTRO-MAGNETIC WATER CONDITIONING

Electro-magnetic water conditioning units shall be provided where specified in **Part 3**.

The units shall be WRC approved and installed, and sized in accordance with the Manufacturer's recommendations.

The units shall comprise an electrical coil which generates a magnetic field that enables the water to cross the magnetic field line at an angle of approximately 90%.

The power supply/control box shall have a polarity reversal mechanism to eliminate routine maintenance of the unit.

2.24 WATER SOFTENERS

SETTING TO WORK

On completion of erection and connection to electrical and water supplies, the Manufacturer shall inspect for correctness of installation and compliance with Water Bye-Laws, and on confirming same shall proceed to formally commission the equipment and leave in working condition.

Provide the necessary testing equipment to carry out hardness testing of water samples together with an estimated one month's salt supply.

2.25 OIL STORAGE TANKS

Oil storage tanks shall be of steel or polyethylene as specified in **Part 3** and to the sizes and capacities as indicated in the schedules and further defined in **Part 3** of the specification.

Steel tanks shall be constructed and tested in accordance with BS 799:Part 5.

Medium density polyethylene tanks shall be constructed and tested in accordance with OFST100 and shall hold an OFCERT licence.

Unless otherwise indicated, each tank shall be provided/fitted with the following:-

- A non-corrodible plate at each filling point clearly indicating the BS grade of fuel being stored.
- Flanged manholes with bolted cover and gasket.
- Fitted internal mild steel access ladder.
- Overfill protection (fill guard unit).
- Vent connection.
- Feed connection.
- Fill connection with fitted internal pipe.
- Drain valve.
- Connection for contents gauge.

For steel tanks, connections shall be welded. 25mm and over shall be flanged unless otherwise specified.

The contents gauge shall be of the continuous indication type with remote reading, and of a weather-proof pattern or located in a weather-proof housing. The gauge shall either be operated hydrostatically, electronically, electrically or by magnetic float. Hydrostatic gauges shall have replacable capillary transmitters, factory calibrated. Each gauge shall be marked "full" and "empty" to indicate the limits of usable oil and intermediate calibration in litres.

- A dipstick or tape calibrated in litres to suit the usable contents.
- A weather-proof audible warning device with test, muting and reset capability. It shall be located at the fill point and set to give a clear warning when the tank has been filled to 90% of its capacity. The warning device shall be capable of indicating that the tank is completely full. A non-corrodible plate indicating its purpose shall be fitted adjacent to the device.
- An outflow heater for residual type oils for Class D when very low temperatures are likely, complete with oil flow temperature indicator.
- A tank immersion heater shall be provided when residual type oils are to be stored or when very low temperatures are likely with Class D oil storage and shall be complete with storage temperature indicator.

External access ladders shall be supplied and fitted to suit the individual location as indicated on the drawings, together with base details, cradle mounts and restraining straps for buried tanks. Each tank shall additionally be cleaned internally and externally coated with anti-corrosion primer and 2 No. coats of oil resistant finish paint, or 3 No. coats of bitumen finish for buried tanks.

2.26 PAINTING

- Ferrous metalwork not galvanised shall have a protective coat of paint or other approved material before despatch from works where it is the normal custom. Any deterioration or damage to manufacturer's protective coating during storage and following installation shall be made good.
- All steelwork fixtures and fittings in external ducts shall be galvanised to prevent corrosion.
- The surface of all ferrous metal work including pipework hangers, supports, etc, shall be primed and finished with one coat of good quality non-metallic paint of approved colour. Where the surfaces will be subjected to temperature above 100°C, the finished coat(s) shall be heat-resisting paint and the primer omitted.
- Surfaces shall be cleaned before they are painted
- Those parts of the installation required to be left unpainted (e.g brasswork) shall be so left.
- The pipework services shall be correctly prepared in order to facilitate the use of approved paint of the correct colour to comply with B.S 1710.
- General Finishing of Installation:-

All work when completed shall be properly and thoroughly cleaned, painted where specified and generally tidied up to present a workmanlike job. Great importance will be attached to this specific requirement which shall especially apply to all items of plant.

Pressure gauges, thermometers, altitude gauges, and thermostat heads shall be neatly installed with the dials arranged in accessible positions for easy reading, the casings and gauge glasses cleaned of dirt and paint where necessary and loose pointers properly set to the working conditions of the system. Brassware must also be cleaned and any dirt neatly removed.

The intention of this requirement is to ensure that the whole installation when completed, shall be handed over to the client in a workmanlike manner with everything properly cleaned, painted, finished and identified.

2.28 PLUMBING INSTALLATION

GENERAL

Drainage connections whether existing or provided by others within this contract shall be checked for location before any work connected with them is commenced. Any discrepancies in location shall be reported.

Before connecting to or breaking into any existing services the levels and locations shall be checked and written notice of the intention to carry out such works shall be given in order that works can be agreed. The method of such connections will be as shown on the "contract issued" drawings or as specified.

During installation and up to the time of handover, the works shall be adequately protected against damage and deterioration.

Particular care must be taken during the course of the works to seal all open ends of pipework to prevent the ingress of debris. The seals shall be purpose made caps, expanding disc stoppers or wood plugs with adequate means of removal. The use of wood shavings, paper and other such materials will not be permitted for this purpose.

All pipes and fittings shall be carefully examined before fixing and any which are defective shall be rejected. The defective materials shall be clearly and permanently marked and removed from site. Damage to coatings shall be made good or recoated.

All pipework shall be erected 25mm clear of and secured truly parallel with vertical surfaces. Horizontal pipework shall be arranged to fall to the gradients shown or the levels indicated on the drawings. Branch wastes from individual fittings or ranges of fittings shall be installed with a minimum gradient of 1.25° (1in 48) unless otherwise noted.

Soil, waste and ventilating stacks, above the highest branches, shall be continued upwards to above roof level at such a height to afford a safe outlet for foul air and be fitted with a non-ferrous wire balloon or cage to suit vent pipe.

Where ventilating pipes pass through a flat roof they shall be provided with a roof connection pipe having a weathering collar or other such weathering device suitable for the roof specification. In instances where pitched roofs are penetrated, ventilating pipes shall be provided with lead slates and weathering collars or similar.

Joints in pipework shall generally not be made within the thickness of walls, floors or roofs unless required by the design and in such circumstances shall be fully tested before any "casting in" or "building in" is carried out.

Access plates on main soil, waste and all rainwater pipes to enable the system to be internally cleared and rodded, shall be fitted at all changes of direction, at branches of 50mm diameter and over, at the lowest point on the stack prior to its connection to drain but above the flood level of any connected fittings and at other positions as indicated on the drawings.

Access shall also be provided on the ends of branch and waste floats or as indicated on the drawings.

Care shall be taken that all points of access are positioned in such a manner as to be accessible particularly in relation to other adjacent services

The provision of access panels in the building fabric, related to rodding access points, is to be checked and any discrepancies notified.

2.28 PLUMBING INSTALLATION

Where pipes other than cast iron pass through walls or floors they shall be protected in one of the following ways:-

- (a) Pipes subject to thermal movement shall be provided with sleeves of a material compatible to the pipe it protects, be non-combustible, of minimum bore to allow such movement and finish flush with finished surfaces. The annular space between the pipe and the sleeve shall be packed with an approved material to prevent the passage of smoke or fire, or in special instances, liquids.
- (b) Pipes not subject to thermal movement shall be protected by two layers of "Denso" tape or other approved materials to prevent the pipe coming into contact with the structure.
- (c) Plastic pipes of over 40mm internal diameter shall, where passing through a fire compartmentation wall or floor, be fire stopped by use of an approved intumescent fire sleeve.

Where indicated on the drawings, stubs wastes shall be installed, in the material specified elsewhere, to provide drainage to a fitting or group of fittings.

The stub shall consist of an oversized vertical pipe with rodding access at the top, of sufficient height to provide connections for the waste pipes from the fittings.

Internal rainwater pipes which may be subject to surface condensation due to icy rainwater are to be thermally insulated to prevent such an occurrence. The specification for this insulation is to be as described elsewhere

Areas and/or pipes to which this applies are covered elsewhere.

Overflows

Overflows to W.C. cisterns shall be run singularly or in groups as shown on the drawings and terminate in readily visible positions. Overflows from concealed cisterns shall be fitted with recessed tundishes to Water Supply Byelaws and Local Water Authority approval. Overflows which terminate in positions remote from the room of origin, shall have permanent notices fitted stating the point of origin.

The wording of all notices and a sample notice shall be submitted to the Architect for approval.

Traps

Traps to soil and waste fitting shall be in copper/copper alloy to B.S.1184.

Traps to soil and waste fittings shall be in polypropylene to B.S.3943.

Traps to fittings discharging chemical waste shall be Polypropylene to Agrément Certificate 92/2805.

Traps to fittings discharging chemical waste shall be Borosilicate Glass 3-3 as BS 2598 and ISO 3585.

All sanitary and laboratory fittings shall be fitted with traps having a 75mm deep water seal unless otherwise noted in this specification or on the drawings.

Pipework Supports

General

Generally, all supports, anchors and fixing accessories shall be provided. For items which are required to be attached to the surface of the building fabric, competent labour and suitable equipment for drilling and securing the support or fixing accessory shall be provided.

2.28 PLUMBING INSTALLATION

Approval of such work shall be obtained prior to its commencement. Where individual fixings require cutting and inserting into the building structure, the positions are to be marked out on site by competent workmen who shall ensure that such fixings are located and set to their requirements.

Where it is proposed to support pipes on cantilever runs of fabricated mild steel section, either bolted or welded, full details of proposals shall be submitted for approval before fabrication.

Full details of all purpose made anchor brackets etc. including methods of fixing, shall be submitted for approval before fabrication.

Multiple pipe supports for pipes of differing sizes shall be spaced at intervals required for the smallest pipe concerned.

All steel supports shall be painted with one coat of rust inhibiting paint prior to erection and shall be free of any rust. Following erection and installation of the piping, the brackets shall be cleaned of rust and painted with a further coat of rust inhibiting paint.

All steel screws shall be schradized coated. Where non-ferrous supports are used or ceramic ware fixed brass screws shall be provided. Soft wood fixing plugs shall not be permitted.

Pipe Supports

On vertical pipe runs there should be at least one support in each storey height which is fixed under a collar or in some other manner to support the vertical load of the pipe to avoid any downward movement.

On horizontal pipe runs there should be a support at each change of direction and in the case of cast iron or any flexibly jointed pipework a support adjacent to each fitting.

The distance between pipe supports should not exceed those shown in the following table:-

Maximum Distance between Pipe Supports

Material	Pipe size	Vertical	Horizontal
Cast Iron	All sizes	3.0m	1.8m
Copper	Up to 25mm 32 to 40mm - 50mm 65mm over	2.4m 3.0m 3.0m 3.7m	1.8m 2.4m 2.7m 3.0m
Steel	Up to 25mm 32mm 40 to 50mm 65 to 75mm 100mm over	3.0m 3.0m 3.7m 4.6m 4.6m	2.4m 2.7m 3.0m 3.7m 4.0m
Polypropylene	38mm 51mm over	1.2m 1.2m	0.5m 0.6m
PVC	32 to 50mm 75 to 100mm 150mm	1.2m 1.8m 1.8m	0.5m 0.9m 1.2m
Borosilicate Glass	20 to 50mm 80 to 150mm	1.7m 1.7m	1.0m 2.0m

2.28 PLUMBING INSTALLATION

Type of Fixing

Cast Iron

Cast iron pipes shall be supported by using any of the following suitable for the location and to provide the neatest possible appearance.

- (a) Cast iron malleable iron or steel, two piece holderbats for building in or screwing to the structure or supporting framework.
- (b) Suspended type pipe hangers and accessories constructed and assembled in accordance with B.S.3974 : Part 1.
- (c) Prefabricated steel cantilever brackets built in or screwed to the structure, the pipe being secured to the cantilever section by "U" bolts and locknuts.

Copper Tubes

Copper tubes shall be supported by using any of the following suitable for the location and to provide the neatest possible appearance.

- (a) Copper or copper alloy holderbats for building in or screwing to the structure or bolting to a supporting framework.
- (b) Suspended type hangers and accessories constructed and assembled in accordance with BS.3974 : Part 1.
- (c) Brass munzing rings with appropriate fixing to the structure or supporting framework.

Contact of dissimilar metals alloys must be avoided. Copper tube shall be supported only by holderbats or pipe rings of copper or copper alloy.

Prefabricated Galvanised Steel

Prefabricated galvanised steel pipe and units shall be supported as follows:-

- (a) At slab levels by means of steel angle welded to the pipe, prior to galvanising.
- (b) All other locations by means of purpose made or proprietary galvanised two piece brackets for building in or screwing to the structure.

Polypropylene

Polypropylene pipes may be supported by using any of the following suitable for the location and to provide the neatest possible appearance:-

- (a) Snap on plastic clips, produced by the manufacturer of the piping system, screwed to the structure.
- (b) Purpose made, two piece plastic coated steel brackets for building in or screwing to the structure or bolting to a supporting framework.
- (c) Continuous lightweight galvanised steel half round channel supported on purpose made brackets fixed to the structure or services framework as applicable.
- (d) Where stress relief units are required or indicated on the drawings, purpose made metal brackets securely restraining the unit are to be used. Details of such restraints shall be submitted for approval and installed to manufacturer's requirements.

2.28 PLUMBING INSTALLATION

P.V.C

PVC pipework shall be supported by using any of the following suitable for the location and to provide the neatest possible appearance:-

- (a) Snap on plastic clips, produced by the manufacturer of the system, screwed to the structure.
- (b) Purpose made, two piece plastic or galvanised coated steel brackets screwed to or built into the structure or bolted to a supporting framework.

Glass

Borosilicate glass pipework shall be supported by using any of the following suitable for the location and to provide the neatest possible appearance:-

- (a) Two piece purpose made plastic coated or plastic lined bracket for building in or screwing to the structure or bolting to a supporting framework.
- (b) Suspended type plastic coated or lined hanger and accessories constructed and assembled in accordance with B.S.3974 Part 1.

Sanitary Fittings

The supply, assembly and fixing of sanitary fittings, as scheduled is to be included in this Contract.

The assembly and fixing of sanitary fittings, as scheduled/given in the Bills of Quantities is to be included in the Contract. Sanitary fittings will be supplied and delivered by others to the locations where they are to be fitted.

The connection of wastes and overflows only is to be included in this Contract.

Any screws or bolts to be provided in connection with supporting or fixing sanitary fittings shall be of the non-ferrous type.

Laboratory Fittings

The supply, assembly and fixing of laboratory fittings, as scheduled/given in the Bills of Quantities, is to be included in this Contract.

The assembly and fixing of laboratory fittings as scheduled/given in the Bills of Quantities is to be included in the Contract. The fittings will be supplied and delivered by others to the locations where they are to be fitted.

The connection of wastes only is included in this Contract. The fittings will be assembled and fixed by others.

Any screws or bolts to be provided in connection with supporting or fixing laboratory fittings shall be of the non-ferrous type.

MATERIALS

General

It will be deemed that all materials to be as detailed in this Specification have been included and no alternative is to be used except where written consent has been previously obtained. All other materials not specifically detailed or mentioned in this Specification shall be to the relevant British Standard, if one exists, or is the best and most suitable of their particular kind.

2.28 PLUMBING INSTALLATION

Cast Iron

Pipes and fittings shall be the Glynwed "Timesaver" system, produced generally to a higher standard than B.S.416 Part 2.

Joints between spigot ended pipe and fittings shall be made using flexible sealed couplings with stainless steel bolts all in accordance with the manufacturers instructions and recommendations.

Connection of other materials to the system shall be made using couplings where outside diameters permit, caulking sockets or screwed bosses.

Copper Pipework and Fittings

Pipes shall be to B.S.2871, Part 1, Table X.

For waste pipes the fittings shall be of copper or copper alloy, specifically designed to carry the flow of water under the conditions of gravity head, of the capillary type to B.S.864 having either an integral solder ring or have the facility for introducing solder.

Bends, springs and sets may be used in pipes up to 42mm diameter where standard fittings cannot be used or where this method will give a neater appearance.

For soil and rainwater pipes welded fittings and joints will be used.

Prefabricated Galvanised Steel Units

These shall be manufactured from medium weight steel tubes to B.S.1387 in accordance with B.S.3868 and galvanised after manufacture.

Jointing shall generally be of the spigot and socket type having an extended depth of socket to give tolerance on length and sealed with a rubber ring.

Joints may also be of the spigot and socket type with normal depth sockets sealed with a purpose made rubber gasket or caulked with an approved caulking compound.

Cutting of pipes on site is not generally permitted but, if agreed, the cut end must be treated with two coats of zinc rich cold galvanised paint and inspected before being installed.

Connections of other materials to the units shall be made by use of screwed bosses and in the case of copper tubes these shall be fitted with insulating connectors.

No units are to be manufactured without site dimensions first having been taken and manufacturing drawings been approved.

Polypropylene Pipework & Fittings

Polypropylene pipes up to and including 150mm dia. shall conform to Agrément Certificate 92/2805 colour black. Fittings shall be manufactured in black polypropylene suitable for mechanical compression or end fusion joints.

Polypropylene pipes up to and including 300mm dia. shall be manufactured to BS 4991 colour beige grey. Fittings shall be suitable for fusion or "O" ring push fit joints.

The preparation and execution of joints shall be carried out strictly in accordance with the manufacturers instructions.

2.28 PLUMBING INSTALLATION

Stress relief joints shall be provided as follows:-

On vertical pipework at the connection to drain above the highest branch and on each floor level above the highest low level branch.

On all horizontal runs at 4m centres unless noted otherwise on the drawings.

Stress relieve units shall be installed and anchored in accordance with the Manufacturer's instructions.

P.V.C Pipe and Fittings

Up to and including 22mm dia. shall be uPVC obtained from, and colour matched to, the same Manufacturer used for the soil and waste system.

Over 22mm diameter and up to 50mm diameter shall be muPVC to B.S.5255 for internal systems.

Over 50mm diameter shall be uPVC to B.S.4514 for internal systems and, where described, for external rainwater systems.

Generally the system will be jointed by solvent welding in strict accordance with the manufacturers instructions.

Seal ring expansion joints, securely anchored shall be fitted on each floor immediately above the branch connections or at maximum 4m centres.

Particular care must be given to the assembly of seal ring expansion joints to ensure a 15mm gap between the end of the pipe and the bottom of the socket to accommodate thermal movement. The insertion depth shall be clearly marked on each pipe to line up with the top edge of the socket. Care must be taken to ensure that this gap is not subsequently closed during further fixing work.

Borosilicate Glass Pipework and Fittings

Borosilicate glass pipework and fittings up to and including 150mm diameter shall be manufactured to the properties of Borosilicate Glass 3-3 as B.S.2598 and ISO 3585.

Jointing shall be by means of stainless steel compression couplings with a nitrile liner and PTFE sheath.

The preparation and execution of joints shall be carried out strictly in accordance with the manufacturer's instructions.

INSPECTIONS, TESTING AND COMMISSIONING

Inspection

The work shall be inspected during installation for workmanship and compliance with the Specification, particular attention being paid to work that will be concealed, any defects noted to be rectified before work proceeds.

Testing

All equipment necessary for testing shall be provided and the Local Authority Inspector advised of testing as and when necessary.

Testing shall be carried out in stages as the work proceeds, particularly items of work which may be inaccessible later. These tests are to be witnessed, any defects revealed by these tests shall be corrected before work proceeds.

2.28 PLUMBING INSTALLATION

All testing shall be witnessed and all parties informed where applicable of the pipework available for testing and for arranging such tests.

The installation shall be air tested in accordance with B.S.5572, Clause 10.31 and any defects which become apparent during the tests shall be rectified at no cost and the parts re-tested.

Prefabricated or pre-assembled units shall be tested at works or place of fabrication and test certificates obtained, copies of which should be handed to the Architect or his representative before the item is installed.

If called for, discharge tests will be carried out in accordance with B.S.5572, Clause 10.3.3 to determine the suitability of trap seals.

The foregoing tests shall in no way relieve the installer of the responsibility for testing the installation on completion. This final test is to be carried out in the presence of and to the satisfaction of all parties concerned.

A record shall be kept of all tests carried out during the Contract, recording the date of test, the result and signed by the person or persons witnessing the test. A copy of these test records shall be issued on completion of the works.

Commissioning

On completion of the works and before handover remove all access plates, rodding eyes, etc., and rod through the installation to ensure that all the pipe bores are clear and free from obstruction, particularly at bends and junctions. Any obstructions must be completely removed. On completion of the rodding and cleaning all gaskets shall be cleaned and greased then all access covers and rodding eyes replaced securely. The whole system including traps shall be thoroughly flushed through with clean water and the whole installation left in a clean and watertight condition.

Within four weeks of the completion of the plumbing works confirm, in writing, the following:-

- (a) The whole of the system has been tested and approved by the Local Authority Officer and/or other parties as required and enclose copies of all test records.
- (b) That the rodding, cleansing and final checking of the system has been carried out and the installation is in working order.

HOT AND COLD WATER SERVICES

The MSC is to supply and fix, Broen ballofix valve terminations, directly below (within 0.5m) any new water outlet points. The MSC is also to make all final connections using braided flexible connections.

Hot and cold water taps are to be installed to the University of Reading's standard, where hot taps are on the left hand side and cold taps are on the right hand side (when facing the appliance)

Drain-off points are to be installed under all sinks, basins and low points.

Internal hot & cold water supplies together with mains cold water, are to be installed in copper tube (BS 2871: part 1 table x). Galvanised pipe work may be used subject to the approval of the URME.

2.29 SPECIALIST GASES

The works and complete system shall be supplied, installed, filled, tested and commissioned by a specialist as described in **Part 3** of the Specification.

The works shall comply with relevant:

Instructions issued by the Health & Safety Executive (HSE)
Health & Safety at Work Act 1974
Pressure Systems and Transportable Gas Container Regulations 1989
The Dangerous Substances (Notification and Marking of Sites) Regulations 1990
British Compressed Gases Association (BCGA) Code of Practice
Liquid Petroleum Gas Institute Technical Association (LPG ITA)
Industrial Gases Committee Codes of Practice

Refer to **Section 2.18 PIPEWORK** – “Laboratory and Medical Gases” page 24 of 48, for further details on pipework requirements.

2.30 CENTRAL VACUUM PLANT

The installation shall comprise of the provision, installation and setting to work of the central vacuum plant, associated equipment, specialist pipeline accessories and automatic control.

The vacuum pump unit shall be designed for use as an “on demand” vacuum system suitable for the environment in which it is located. The unit shall comprise a vacuum reservoir, two single stage rotary vacuum pumps, electrical control system, gauges, valves and connection pipework supplied as a packaged unit.

The vacuum pumping unit described shall provide general vacuum for use throughout the facility.

The pump set shall be designed to handle the flow rates indicated in Part 3 of the specification.

The principal mechanical components of the pumping system shall be as noted below and shown on the drawings:-

- Rotary Vacuum Pump (single stage)
- Vacuum Switch (User adjustable)
- Capsule Dial Gauge
- Oil Mist Filters
- Vacuum Switches

A catchpot shall be supplied and mounted on the common vacuum reservoir inlet. The catchpot shall have a valved drain point.

Principle of Operation

The vacuum reservoir shall be pumped down to a pre-set pressure by means of a selectable “duty” single stage rotary vacuum pump. An identical secondary selectable “standby” pump shall be configured to assist the duty pump automatically during high demand conditions. The “duty” and “standby” pump shall be selected via the control panel to ensure even usage of both pumps.

The unit shall be used in either continuous or cyclic operation. In cyclic operation, the vacuum reservoir shall be pumped down to a pre-set range by the pumps. The pump shall be controlled by two vacuum pressure switches. These switches set the pre-set pressure range between the low and the high settings during cyclic operation. In continuous operation, the duty pump operates continuously and the pressure in the reservoir is kept as low as possible.

The above features shall provide an automatic changeover facility on pump failure. Such a pump failure shall provide via VFC a signal to the BMS to indicate pump failure (i.e. pump trip).

It is intended that the unit shall operate on a cyclic basis.

Control Panel and Control/Monitoring Components

A self-contained packaged control panel supplied with the vacuum pump unit shall house isolation, control circuits, contactors and indicators, all pre- or site wired as necessary to the control switches.

A 3 position control switch shall provide user adjustable off, cyclic or continuous operation of the vacuum pump package.

The control package shall also include the following features:-

- Selector switch for run & standby vacuum pumps.
- Volt free relay contacts for:-
 - Pump 1 run
 - Pump 1 trip
 - Pump 2 run
 - Pump 2 trip

2.30 CENTRAL VACUUM PLANT

The run signal via VFC for each pump shall allow logging of hours run for each pump on the BMS.

- 2 No. Active strain gauges (1 No. to each pump inlet) and matching Active Digital display each providing, via volt free contacts, for:-

Pump 1 high limit
Pump 1 low limit
Pump 2 high limit
Pump 2 low limit

Each of these contacts shall be connected to the BMS.

Additionally, a further active strain gauge shall be field mounted in the common inlet pipe connection to the vacuum pumping unit by the Specialist. A matching digital display and strain shall be issued to the Automatic Controls Specialist for incorporation within the MCC. This shall provide analogue display of vacuum to the BMS via a suitable output signal.

Electrical Supply

The packaged unit shall have a single electrical supply to suit the ratings indicated in Part 3 of the Specification.

Vacuum Installation Generally

Pipework shall be Table X copper as described elsewhere in this specification. Valves shall be as described elsewhere. All to comply with relevant Guides and Codes of Practice.

Testing & Commissioning of the Pipeline & Installation

Testing & commissioning of the pipeline and installation shall accord with relevant Codes of Practice and in addition to plant commission and testing, shall comprise at least:-

- Purging and pressure testing using inert gas or oil free air.
- Pipelines shall be cleaned after installation by purging using clean, dry nitrogen at a velocity higher than will be experienced in service.
- Removal and refitting of components sensitive to test pressures.
- Minimum test pressure 2.0 bar for a minimum of 30 minutes.
- Complete Installation leakage test.
- Anti-confusion test comprising isolation of all other gas services (compressed air, natural gas and CO₂) and testing of every outlet/every room to ensure no cross connection.
- Pipeline identification check to ensure no confusion.
- Complete system leakage test under vacuum at its maximum (lowest) design setting. The vacuum shall not decrease by more than 2% over a period of at least 30 minutes.

2.31 COMPRESSED AIR INSTALLATION

The installation shall comprise of the supply, installation and setting to work of the central compressed air plant and associated pipework and accessories indicated in Part 3 of the specification.

The installation shall be as shown on the drawings and comprise the main components listed below.

The compressed air plant shall deliver oil, moisture and dust free air at a dew point of -40°C to the distribution system.

2.31.1 Compressed Air Plant

The main system components shall be:-

Air Compressors

Rotary vane air compressors with 415V/3Ph/50Hz TEFC IP55 Glass F insulation electric motor. Each compressor shall be complete with a fitted airblast aftercooler for bulk moisture removal and an auto star delta starter with electronic control panel for running settings and diagnostic information. The complete package shall be housed in an acoustic enclosure to maintain a maximum noise level of 66dB(A).

Each compressor shall have volt free contacts for common fault transfer to the BMS.

Air Receiver

Certical legged air receiver supplied complete with air gauge, safety relief valve, mechanical drainer valve and test certificates. Constructed to BS EN 286. Finished in one coat of phosphate primer and one coat of high gloss.

The drain solenoid valve shall have VFC for fault alarm to BMS (see Automatic Condensate Drain Traps).

Pre-Filters

General purpose protection coalescing filter capable of removing oil and dirt particles down to 1 micron. Maximum aerosol content 0.5ppm at 21°C. Fitted with a differential pressure gauge for showing state of filter element.

High efficiency oil removal coalescing filter capable of removing oil and dirt particles down to 0.01 micron. Maximum remaining oil aerosol content 0.01ppm at 21°C. Fitted with a differential pressure gauge for showing state of filter element.

Mounting bracket kits for clamping filters together with a modular construction.

Air Dryer

Heatless dessicant airdryer capable of drying compressed air down to a pressure dewpoint of -40°C.

After Filter (Fitted after Air Dryer)

General purpose dust filter capable of removing solid particulate generated by the dessicant air dryer.

Automatic Condensate Drain Traps

Electronic automatic drain trap for the removal of condensate from aftercoolers, air receivers, air dryers and filters, requiring 240 volt single phase power supply. Fitted with test facility illuminated alarm power on LED lights and VFC for fault alarm to the BMS.

Ditto to be located in low points in the compressed air pipework.

2.31 COMPRESSED AIR INSTALLATION

Oil/Water Separator

Oil/water separator, designed for the collection of compressed air condensate to comply with the WRC regulations.

Control Panel

Duty/changeover panel for automatic operation of two air compressors.

The control panel shall have pressure switches for switching each compressor on a run/standby basis. A selector switch in the panel shall provide manual selection of the duty machine and via volt free contact, permit automatic duty rotation of the duty machine by the BMS. Pressure switches shall also provide volt free interface with the BMS for low pressure (machine failure etc) and very low pressure. The control panel shall permit the compressors to operate on a duty/assist basis should demand exceed the capacity of a single machine.

The control panel shall have volt free contact to receive a run signal from the BMS and permit time control of the plant.

2.31.2 Compressed Air Installation System

Distribution pipework shall be generally as indicated in Part 3 of the specification. All to comply with relevant guidelines and Codes of Practice.

2.31.3 Testing & Commissioning of the Pipelines & Installation

Testing & commissioning of the pipeline and installation shall accord with relevant Codes of Practice and in addition to plant commission and testing, shall comprise at least:-

- Purging and pressure testing using inert gas or oil free air.
- Pipelines shall be cleaned after installation by purging using clean, dry nitrogen at a velocity higher than will be experienced in service.
- Removal and refitting of components sensitive to test pressures.
- Minimum test pressure 2.0 bar for a minimum of 30 minutes.
- Complete Installation leakage test.
- Anti-confusion test comprising isolation of all other gas services (compressed air, natural gas and CO₂) and testing of every outlet/every room to ensure no cross connection.
- Pipeline identification check to ensure no confusion.
- Complete system leakage test under vacuum at its maximum (lowest) design setting. The compressed air shall not decreased by more than 2% over a period of at least 30 minutes.

2.31.4 Distribution System Drains

Drains shall be fitted as noted on the drawings.

2.31.5 Point of Use Equipment

Each point of use (or pair as noted on the drawings) shall be fitted with an automatically venting isolating valve and filter regulator assembly. These shall have integral valves and 15mm inlet and outlet connections. Drain points shall not be connected.

2.31 COMPRESSED AIR INSTALLATION

2.31.6 Compressor Enclosure Ventilation

Each enclosure shall have free air inlet via integral filters. The cooling air outlet shall be ducted to atmosphere. Each cooling air discharge system shall be as indicated in Part 3 of the specification.

Each fan shall be interlocked with the respective compressor unit to operate continually when the compressor is running. Power and control of each enclosure ventilation shall be derived from the MCC.

2.32 REVERSE OSMOSIS (RO) WATER SYSTEMS

The installation shall comprise of the entire RO water system.

2.32.1 RO Water Plant Generally

The system will comprise reverse osmosis units feeding storage tanks. Water contained in the storage tanks shall then be recirculated to the points of use in the building via ring main distribution systems, each with their own plant items.

The plant items shall include auto-changeover de-ionisation cylinders on each system, timed for every 4 hours as well as on cylinder exhaustion and a 0.45 micron absolute rated filter.

A central control panel shall provide the power feed to all RO plant items from a single electrical supply rated at 13amp. The control panel shall also initiate the operation as called for by the level switches within either the tank providing pump run and trip indication as well as controlling pump operation on low level. Tank level controls shall have a changeover switch so as to control from either tank. A pair of resistivity monitors with alarm set points at 1 megohm-cm will provide an auto-changeover facility on water quality and also every 4 hours to prevent bacterial build-up.

The control panel shall provide volt free contacts for the plant alarm items either individually or as a single alarm as noted below.

General Specification

It shall be noted that the specialist should obtain water samples for analysis to confirm the system requirements.

The system will comprise:-

5 micron carbon based pre-treatment filter.

Reverse osmosis water purification units, each capable of producing primary grade water at a rate of up to 60 litres per hour feeding into a storage tank, from a feedwater at 15°C.

Each unit shall be supplied with an integral pre-filter and mains supply break tank, providing protection from gross particulate contamination and chlorine damage, and enabling routine semi-automatic disinfection. Continuity of water quality is to be ensured by an auto-rinse facility, whereby the reverse osmosis membranes are flushed to drain at regular intervals.

The Specialist shall pipe the drain connection to discharge over a local drain.

Each unit shall be connected in such a way that each tank can be used independently with level control via a selector switch.

Each unit shall have status display. Alarm values are to be user definable and shall be relayed to the central RO system control panel described below.

Storage/recirculation tank manufactured from black, food grade polypropylene and supplied with conical base, tight-fitting lid, non-return overflow, 0.2µ bacterial air filter, automatic level controls and valved pipe fittings, including balance pipework, as noted on the drawings.

The tank shall be provided and installed with all necessary supports by the system specialist. Overflows and tank drains shall be piped by the specialist to discharge over a local drain.

Pump control should be from either tank with a suction manifold to suit.

Stainless steel recirculation pumps, complete with manifold, pressure relief valve, pressure gauges and inlet and outlet fittings, as noted on the drawings.

2.32 REVERSE OSMOSIS (RO) WATER SYSTEMS

Standby mixed-bed de-ionisation cylinders, complete with inlet/outlet connections, to provide pure water quality in the range of 1-10 megohm-cm. These to be selected to suit the specified throughput and water quality.

Note: 2 No. deionisation cylinders are required per ring main.

Filter housing assemblies complete with 0.45 micron absolute rated filter element, filter housing and stainless steel differential pressure gauges.

Resistivity monitors shall be provided and installed as shown on the drawings. These shall perform changeover function on de-ionisation cylinders and provide an analogue water quality output via the control panel for BMS logging.

Temperature sensors (and pockets) located in each ring circuit shall provide analogue output of water temperature via the control panel for BMS logging.

Note: Temperature sensors in the RO system shall be provided by the controls specialist and installed in pockets provided by the RO specialist. Other sensors mentioned above to be supplied and installed by the RO specialist.

Central control panel providing power distribution to all RO water system components and plant items to enable proper function including (but not limited to):-

Power Supply:	240V/1Ph/50Hz
Controls for:	<ul style="list-style-type: none">• Each unit• Storage tank level controls switchable to each tank• Recirculation pumps (run & trip)• Timed and quality changeover of de-ionisation cylinders
Alarm/Output Facilities for:	<ul style="list-style-type: none">• Water quality alarm (VFC)• Low storage tank level (VFC)• Pump run/trip (VFC)• Common storage tank water quality sensor megohm-cm (analogue)• 2 No. (each ring) water quality sensor megohm-cm (analogue)• Volume treated output for connection to the BMS.• 1 No. common water quality sensor megohm (analogue)

Reference shall be made to standards elsewhere in this specification concerning control panel construction.

2.32.2 RO Water Installation & Distribution System

The Specialist shall provide all materials and labour necessary to install the above plant items.

Each ring main shall be run in ABS nominal bore ABS Class E to the points of use as detailed on the drawings.

This installation shall include all necessary pipeline components, valves fittings and the like to make a completely functional installation. Service isolation valves shall be provided at each draw off point. Where isolation is required to an item of equipment, such isolation shall be a single diaphragm valve on a dead leg of the minimum length possible. Where the RO water ring main passes demand points such as bench outlets, isolation valves shall be provided on the upstream and downstream side of the draw off point.

Service isolation valves shall be provided on each flow and return connection to each RO water outlet.

2.32 REVERSE OSMOSIS (RO) WATER SYSTEMS

Commissioning and Sanitisation

The specialist shall provide all necessary materials and labour required to completely sanitise and commission the RO water system and hand over in a full working order.

The specialist shall not use carbon tetrachloride in the sanitisation of the installation.

GENERAL

All fume cupboards will comply with recommendations and requirements indicated in BS 7258:1990:Parts 1-4: 1994, relating to fume cupboards and their installation, together with appropriate COSHH and Health and Safety Regulations.

A certificate shall be provided showing that the fume cupboard has been type tested in accordance with the DIN 12924 procedure and is within the limits of the static and dynamic containment test of the Standard at the Supplier's recommended face velocity.

The electrical wiring installation forming part of the fume cupboard installation shall comply with the Institution of Electrical Engineers Regulations as detailed in BS 7671.

Piped services connections forming part of the fume cupboard shall comply with all appropriate British Standards, Water Regulations and BCGA Codes of Practice.

The colour requirements of individual cupboards will be specified within **Fume Cupboard Supplementary Specification**

Working Width

Working width relates to a normal work surface dimension, and **not** the overall fume cupboard dimension.

The overall width of the fume cupboard will be the sum of the working width plus the side aerofoils and service panels.

Face Velocities

Unless stated otherwise, the average face velocity at the normal working opening shall be **0.5m/s**, with a permissible deviation of **0.05m/s** with the cupboard empty, at a sash opening of 500mm.

A performance test certificate shall be provided for each cupboard, indicating this requirement has been met.

Air By-Pass

The fume cupboards shall be of the face and bypass (constant volume) type, unless specified otherwise within the **Fume Cupboard Supplementary Specification**.

The full width by-pass system is to have sealing glands arrangement to ensure that when the sash is raised vertically the by-pass system is sealed and all available extract air is drawn through sash apertures.

It shall be possible to gain full access to the upper part of the chamber by raising the grille on suitable hinges, and to remove the grille for cleaning.

The air by-pass grille shall not allow the egress of any material in event of a minor explosion within the fume cupboard and shall be of the double layer hit and miss type to prevent this.

Sash

The sash shall be arranged such that, in its raised position, it does not exceed the overall height of the cupboard construction and does not pass through the soffit of the chamber.

It shall be of the double sash type configured such that the top half closes the by-pass at half the rate at which the working opening increases.

A normal working height shall be determined by a sash limit stop, which it shall be possible to release, but will automatically re-engage as the sash is lowered. This shall be configured to give a working opening of 500mm.

In the fully raised position, the sash opening height shall be 900mm minimum. To achieve this arrangement a mechanical stop is to have a key mechanism over-ride facility, which when operated allows the sash to be raised to its full extent. The stop shall automatically be reset when the sash is lowered.

2.33 FUME CUPBOARDS

A minimum gap of 25mm shall be maintained by a stop when the sash is in the fully lowered position. A lockable arrangement shall be incorporated, to prevent the sash being opened and allowing the cupboard to be used, when maintenance is being undertaken.

The sash shall be constructed of 6mm thick clear toughened glass to BS 952 Part 1, with a BS kite-mark clearly displayed. It is to be locating into side channels, and provided with a full width aerodynamically designed handle in a colour as specified within the Fume Cupboard Supplementary Specification.

The sash shall be supported by twin stainless steel wires, running over smooth action pulleys, and linked to a suitable counterweight. It shall not be possible for the sash to fall if one of the suspension wires breaks.

Aerofoils

The fume cupboard shall have aerofoils arranged to give least disturbance to the entering airflow. Mechanical outlet valves will not be permitted on the aerofoils.

The lower worktop aerofoil shall be positioned so that a minimum of 25mm is maintained below the underside of the aerofoil and the worktop. The aerofoil shall be constructed in materials as specified within t the Fume Cupboard Supplementary Specification.

Working Chamber

The interior of the working chamber shall provide a minimum height of 1500mm. The lining to the chamber shall be as specified in the Fume Cupboard Supplementary Specification.

The roof of the chamber shall be fitted with a sealed toughened glass panel to permit light from a fitting mounted above. A duct outlet shall be fitted within the roof, at the back of the chamber, which shall be suitably sized to minimise noise at the stated extract levels and the recommended transport velocity.

Baffles

Back baffle plates shall be fitted to achieve both low and high level exhaust within the chamber, and direct the air flow to ensure the thorough purging of fumes from every part of the working chamber.

The baffle is to be easily removed for maintenance and cleaning purposes.

The design of the baffle is to be such that no metal parts are to be in contact with the fumes.

Worktops

The worktop shall be manufactured from cast epoxy resin, and dished to retain upto 2.5 litres of liquids, unless specified otherwise in the Fume Cupboard Supplementary Specification.

The worktop shall be fully sealed to the working chamber to prevent penetration of chemicals. Drip cups, sinks, or troughs shall be provided within the worktop and shall be of the type and material specified within the Fume Cupboard Supplementary Specification.

Airflow Alarm

An EVERWATCH face velocity monitor shall be fitted to external RHS front service panel of the fume cupboard, complete with venting kit. It will provide a digital read-out of the measured face velocity, a low and high audible alarm with mute, and to warn of a high sash position resulting in a low face velocity.

If specified within the Fume Cupboard Supplementary Specification. The fume extract alarm shall provide a linear 0-10V DC output for remote monitoring of the face velocity and low and high alarm contacts for remote monitoring.

2.33 FUME CUPBOARDS

Lighting

The fume cupboard shall include a ventilated light reflector housing, complete with quick release fasteners for maintenance inspections. The fluorescent light will give a minimum lighting level of 400 lux on the working surface of the chamber. All fittings shall be complete with high frequency control gear.

All luminaires shall be fully sealed from the ventilated space and shall comprise of florescent lamps with reflectors mounted above a laminated safety glass panel forming an IP65 enclosure (minimum). Control gear to be mounted on top of the luminaire.

The light reflector housing and safety glass panel is to be constructed to ensure that it is sealed from the atmosphere and the inner chamber.

A switch shall be fitted in an easily visible position from the normal operating position, and shall be suitably engraved.

Electrical Services

The fume cupboard shall be delivered to site pre-wired

All wiring shall be single core PVC insulated cable, run in non-metallic conduit or trunking.

Electrical service outlets complete with RCD and neon indicator shall be mounted on the front panel as specified within the Fume Cupboard Supplementary Specification.

The electrical services are to be taken to a top mounted junction box. The wiring compilation is to be arranged as follows: -

- I. Power sockets and lighting to be arranged in a local ring circuit format. The lighting circuit fused 3 amp.
- II. 3 amp fused circuit for EVERWATCH air monitor (fascia mounted).
- III. The lighting switch will activate the control circuit for the fume cupboard's fan and the Everwatch circuit.

All cupboards are to be fitted with a flush surface mounted EVERWATCH Face Velocity Monitoring System.

All electrical services outlets (sockets, fused connection units etc,) shall be of the MK Logic Plus range

Fume cupboards shall be designed such that split liquids and vapours cannot come into contact with the power outlets.

All control fascia panels and switches are to be suitably engraved.

A dedicated earthing cable shall be run in every conduit/trunking. All neutrals shall be the same size as conductors. Earth sizes shall be as the current IEE Regulations

Service Outlets

The fume cupboard is to be pre plumbed, pressure tested, purged and flushed clean during manufacture, and come complete with a test certificates to this effect.

The service outlets shall be provided in accordance with the Fume Cupboard Supplementary Specification.

All service outlet pipework will be installed in copper tube to BS2871 (table X). Dry services shall be run in medical quality (degreased) copper and installed in accordance HTM 2022.

Mechanical service outlets shall be mounted on the side of the working chamber, operated from control valves directly in line with the outlet and external to the working chamber on the side front fascia panel. The control valves shall be colour coded to DIN- 12920 recommendations to indicate the service and discharge above the worktop. The service taps are to be manufactured by Broen. Boss

Water and other wet service outlets shall discharge vertically down and over a drip cup or into a sink bowl.

2.33 FUME CUPBOARDS

Piped connections shall be provided between the valve and the service outlet. The valve inlet shall be piped to the back of the cupboard, below worktop level, and terminate with a plain end.

Outlet nozzles shall be as specified within the **Fume Cupboard Supplementary Specification**.

Drainage

The fume cupboard manufacturer is responsible for the provision of local drainage facilities i.e. Up to the trap outlet.

Unless as specified otherwise within the **Fume Cupboard Supplementary Specification**, Vulcathene tubular traps are to be used.

All wastes to sinks and drip cups shall have removable strainers

Underbench Cupboard

Fume cupboards shall incorporate a full width underbench storage cupboard. They shall be permanently ventilated through the fume cupboard extract system via a separate duct between the underbench cupboard and the fume cupboard duct outlet.

The type of cupboards will be as specified within in the **Fume Cupboard Supplementary Specification**. They will however conform to either of the following designs.

OPTION 1

The cupboard shall be fitted with a track hung sliding doors, complete with a bottom stay bracket that will maintain a minimum 25mm air gap between the backs of the doors and the bottom shelf of the cupboard.

The back of the cupboard shall be removable to allow access to the service connections.

2 No. PVC storage trays shall be provided to each ventilated storage cupboard.

OPTION 2

The cupboard shall be constructed from steel for use with flammable liquids. The units are to comply with the Highly Flammable Liquids and Petroleum Gases Regulations 5 (ID) and guide to the regulations number S (17) together with the Factory Inspectorates 'Certificate of Approval' No 1, parts 3 and 4, all constructed from 20 gauge zinc steel with spot welded seams throughout.

The unit is to have a removable liquid tight shelf deep bottom tray to retain spillage, both lined with a polypropylene leak-proof tray. An integral door lip to assist in providing a vapour seal with door.

The doors shall be reinforced with a vertical panel to prevent distortion due to heat under fire conditions.

Doors are to have a 'T' handle lock and key.

Labelling and Identification

A label shall be provided on each fume cupboard, indicating the University's reference number, the design-working opening, the face velocity, and with a space for test velocities and dates to be subsequently recorded.

Drawings

The manufacturers will produce working drawings of the proposed cupboard and extract system (if let as a complete package), indicating all mechanical and electrical services, route of ductwork, fans and discharge points etc. These drawing are to be provided to the University of Reading and approved prior to manufacture.

2.33 FUME CUPBOARDS

The manufactures must state at the time of tender, the delivery period and on site construction period upon final approval of the shop drawings.

Testing and Commissioning

The fume cupboard manufacturer is to provide when requested skilled and experience staff, in conjunction with the installer / commissioning engineers of the supply and or extract systems. The manufacturers will liaise with the BMS specialist as detailed within the Fume Cupboard Supplementary Specification.

The operation of each fume cupboard shall be commissioned in conjunction with the manufacturer (and Full containment testing will be required under the contract in accordance with the requirement of BS 7258: 1994.

Following satisfactory testing and commissioning, a demonstration will be arranged with the University of Reading, when operators of the facilities will be formally briefed.

The complete installation shall fully comply with BS 7258:Parts 1, 2, 3 and 4.

Following the installation and commissioning, all test results are to be supplied. Test certificates, air face velocities, ductwork test results and pressure drop data for filters and shop drawings etc., are to form the basis of the O & M Manuals.

The Fume Cupboard Manufacturer is to provide to the Main Contractor or the University of Readings Supervising Officer, 2 sets of Operating & Maintenance Manuals **two weeks** before the date of Practical Completion or before an agreed handover date. **Failure to provide the manuals shall result in the withholding of payment to the Fume Cupboard Manufacturer to cover the provision of the O & M Manuals by another party. The sum withheld shall not be less than £1000.**

Under the COSHH Regulations it is essential that the as installed operating performance is provided as a baseline for future testing, maintenance and insurance inspections.

Fume Cupboard Fan Units

Fans shall be of the forward curved centrifugal type, with all parts, which are likely to come into contact with fume manufactured from suitably resistant materials.

The fans shall be arranged for indirect drive, with underslung motor, via pulley wheels and a V-belt. They shall be sized to give 10% additional volume to the fume cupboard requirement in accordance with the recommendations of BS 7258:1990.

All motors shall be 3-phase and totally enclosed. Where appropriate, they shall be suitable for external mounting with a suitable weatherproof cover, removable for access.

Connections to the fans shall be of flexible PVC, which shall permit the fan to be removed after installation.

Fan casing shall be vacuum formed - CNC machined (CMV125-400) in PVC or polypropylene to give optimum flow characteristics and a high precision first class finish, all other sizes will have fabricated cases.

The inlet and discharge will be circular spigots, the discharge having an external flange of at least 12mm in thickness.

The inlet section shall be removable complete with integral O-ring gasket and secured by stainless steel bolts.

Each casing shall be fitted with a drain socket positioned at the lowest point to allow complete drainage of the case of any condensate.

Casing support and frame shall be manufactured using heavy gauge mild steel complete with base fixing holes and anti-vibration mountings. All steelwork to be painted with at least two coats of chlorinated rubber paint.

Fan impellers shall be moulded from polypropylene. All impellers shall be statically and dynamically balanced to the relevant British Standards.

2.33 FUME CUPBOARDS

All impellers shall be fixed to the fan/motor shaft by means of a keyway and centre bolt protected by a cap to prevent exhaust fumes coming in contact with any metallic parts.

All fan units to be V-belt drive in accordance with BS 3790.

Motors shall be TEFC weatherproofed to IP55 to BS 5000, BS 4999.

Fans shall be guaranteed to perform to BS 848:Part 1:1985.

All fans shall carry a 12 month guarantee from date of installation covering all materials and workmanship.

No leakage will be permitted from the fans or connections either under operation or at rest.

Sound Pressure Levels

Where silencers / attenuators are required they shall restrict the transmission of air borne noise to NR40 within the laboratory and NR50 to outside.

In the absence of silencers / attenuators being specified, the system shall be designed and operate in accordance with current good practice standards within the Industry.

GRP UNITS

Construction

The fume cupboard shall be a freestanding floor mounted unit.

The cupboard will be fitted with a bypass to ensure that the total extract volume from the cupboard remains constant.

The basic construction will consist of a 'one piece' moulding from chemical resistant fire retarded resin glass fibre laminate. This shall provide a smooth joint free impervious internal lining. A full width moulded sink complete with waste is to be included.

The external carcass is to be formed on both sides and across the rear of the fume cupboard to provide an enclosed housing for the inner 'one piece' chamber, sash mechanisms and tap controls.

The 'one piece' moulded inner chamber is to have an aerodynamically shaped roof leading to a rectangular extract outlet which is to be positioned to give an even flow through the chamber and across the width of the sash.

The internal surfaces of the walls and roof are to be white.

All materials for the inner chamber shall be self extinguishing, high heat resistant chemically resistance glass fibre laminate complying with BS476 Part 7 and BS3532: 1990.

The fume cupboard support frames shall be constructed in mild steel complete with either fully moulded joints or stainless steel fixings and finished in either a chemical resistant epoxy paint or polyester powder coating. The legs of the frame are to have adjustable feet on each leg.

Side service panels shall be provided at each end of the fume cupboard to accommodate access to services.

POWDER COATED STEEL SHEET UNITS

Construction

The fume cupboards shall be a freestanding floor mounted unit

The cupboard will be fitted with a bypass grille at high level (about 2m) such that when the sash is lowered to any intermediate position, the total extract volume from the cupboard remains constant.

2.33 FUME CUPBOARDS

The cupboard cabinet shall be twin skin construction, having an outer aerodynamically designed carcasses. The outer carcasses shall be constructed in steel sheet, zinc coated and electrostatic epoxy / polyester coated

The internal surfaces of the walls and roof are to be white polypropylene lined.

The fume cupboard support frames shall be constructed in mild steel complete with either fully moulded joints or stainless steel fixings and finished in either a chemical resistant epoxy or polyester powder coating. The legs of the frame are to have adjustable feet on each leg.

Side service panels shall be provided at each end of the fume cupboard to accommodate access to services.

WASHER / DEMIST SCRUBBER

A fume scrubber shall be designed, manufactured, supplied, installed, tested and commissioned as a composite part of the fume cupboard installation.

The scrubber shall be installed within the envelope of the new cupboard carcass to provide efficient removal of airborne contaminants.

The scrubber equipment may be located under the fume cupboard in place of the usual ventilated, chemical or flammable storage cupboards.

An efficiency of greater than 99% shall be maintained at all times with the least possible pressure loss.

All contaminants shall be trapped and held within the scrubber fluid, which shall be raw water.

The scrubbing fluid shall operate on a closed re-circulating system requiring manual drainage and refilling of the system to establish the containment characteristics of the scrubber.

An in-line filter shall be provided to prevent growths being transferred from the sump.

There should be no spray entering the cabinet when the scrubber is switched on.

The fume cupboard may be used for non-scrubbing operations requiring only extract and shall therefore be equipped with a scrubber inhibit key switch.

The scrubber inhibit key switch shall be mounted in the fascia of the cupboard and locally stop the scrubber from operating, start a warning buzzer and illuminate a warning light.

The warning buzzer shall be capable of being muted by operation of a second key switch.

The scrubber inhibit key switch, warning buzzer, warning light and buzzer mute key switch shall all be mounted in a common accessory plate engraved to indicate the purpose of each item.

The acids to be used within this fume cupboard are: Fuming Sulphuric Acid, Aqua Regia, Hydrochloric Acid, Perchloric Acid and Nitric Acid.

2.34 OPERATION AND MAINTENANCE MANUALS

O & M MANUALS

O & M manuals are to be provided by the MSC between **two and four weeks** (to be agreed depending upon the size of the project) prior to the date of Practical Completion, a **draft copy** of the Mechanical Operation & Maintenance Manual for approval. The contents are to be as listed below, with the exception of final commissioning data and test certificates.

Following approval, the MSC is to provide to the Main Contractor **2 sets** of Operating & Maintenance Manuals **one week** before the date of Practical Completion. **Failure to provide the manuals shall result in the withholding of payment to the MSC to cover the provision of the O & M Manuals by another party.**

The sum withheld shall not be less than £1000.

One week before the date of Practical Completion, the Main Contractor is to hand the **2 sets** of Operating & Maintenance Manuals to an Estates Services Representative, for re-distribution.

In addition to the above, manufacturers literature and a basic users guide to the plant operation must be provided upon handover. The guide is to take the form of an A4 sheet encapsulated in plastic and fixed in the plant room or adjacent to the control panel by the MSC.

The Contractor will present each manual in the following form: -

FOLDERS

A 4 ring binders with a front corner pocket. All contents to be in A4 plastic pockets. The Folder shall indicate on the front cover and the leasing edge:

- a) Name of Building
- b) University Building No.
- c) Service (Mechanical or Electrical)
- d) Year
- e) Volume One or Two (if applicable)

CONTENTS OF MANUAL

Shall contain the following information in order listed below: -

- a) Job Title
- b) Contractors Details (address, telephone, fax)
- c) Details of specialist Suppliers or Sub-Contractors (address, telephone, fax and plant items)
- d) Emergency Call-Out Details (Normal Hrs and Out of Normal Hours NO)
- e) Block Plan of building indicating utility service entry points if applicable
- f) Sheet containing an Index of the Contents of the manual indicating Section Number
- g) The main contents to be in the following sections: -

Section one - Specification and amendments

Section two - General description of systems

Section three Plant Inventory: To include: Manufacturer
Telephone
Fax
Location
Number off
Duty (Design)

Section four Maintenance requirements. Service schedules and program months are to be included.

2.34 OPERATION AND MAINTENANCE MANUALS

Section five	Manufacturers literature (indexed) including electric supply, controls and ancillaries.
Section six	As installed drawings (indexed). Each drawing to be A1 folded and contained in an A4 plastic pocket with the drawing number in the bottom right corner. Drawings are acceptable on A4/A3 where they have been specifically drawn on these sized sheets.
Section seven	Commissioning Results (indexed)
Section eight	Other Test Sheets - i.e. Pressure Test Sheets and Boiler Test Certificates including Combustion Test.
Section nine	Health & Safety referrals

The Contractor will keep on site a specific set of drawings for the sole purpose of making clear notes of any amendments, which take place during the contract. The Clerk of Works will ensure that this practice is being carried out.

WHERE A PROJECT IS COVERED UNDER CDM REGULATIONS THE O&M'S WILL FORM PART OF THE H&S FILES.