

Mechanical Services General Performance Specification

AC Replacement Works - Tamworth building

College of Policing
Gleeds Building Surveying Ltd
NTBS 4073

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1 Introduction

This part of the Specification shall be read in conjunction with all other sections of the tender documentation and applied to those sections as appropriate.

2 Installation Standard

The entire Mechanical installation and components shall, unless stated otherwise in the Particular Specification Section, comply with the following:-

- a) British Standard Codes of Practice.
- b) British Standard Specification.
- c) The latest issue of the Guide to Current Practice by the Chartered Institution of Building Services Engineers.
- d) The regulations of the Local Authority, Central Electricity Generating Board, Water Authority and Gas Council.
- e) Manufacturer's stipulations and recommendations for installation and testing.
- f) The Loss Prevention Council rules for fire protection installations.
- g) Current edition of the IEE Regulations.
- h) Current edition of the Institute of Plumbing 'Plumbing Services Design Guide'.
- i) The Offices, Shops and Railways Premises Act, the Factories Act, Government Wages Resolutions and the Health and Safety at Work Act.
- j) Any apparent discrepancy between the above specified regulations, the tender drawings and Specification shall be advised to the Client's appointed engineer prior to the relevant works proceeding for instruction as to the procedure to follow.

3 Pipework Fittings & Installation

3.1 General

Pipework shall be in accordance with the standards subsequently specified.

The finish, table and grade applicable shall be as detailed in the relevant sections of the Particular Specification. Where the table or grade is not specified, these shall be in accordance with appropriate test pressure and temperature range of the system.

This part of the Specification shall be read in conjunction with the requirements of clauses dealing with welding and structure and steelwork fixings.

3.2 Pipes

| <u>Pipework</u> | <u>Standard</u> |
|-----------------|----------------------------------|
| Steel | BS EN 10255: (10.2 - 165.1mm CD) |
| Steel | BS EN 10224: (26.9 - 2,743mm CD) |
| Copper | BS EN 1057 |
| Plastic | BS EN 7291 |

3.3 MS Pipework & Fittings

Pipework of 65mm diameter and above shall be welded and pipework up to and including 50mm diameter shall be screw threaded, unless otherwise stated in the Particular.

Where the Specification calls for a screwed assembly, malleable CI banded or beaded fittings to BS EN 10241 shall be used. Welding fittings shall be to BS EN 10217.

Where standard fittings are available, the use of bushings shall not be permitted.

Pitcher tees shall be used at ALL branches. Square tees shall be used for air venting.

The drilling of fittings for the insertion of air vents etc. shall not be permitted.

Unions shall be bronze-faced conical seated pattern.

All pipework, whether of welded or screwed assembly, shall have a sufficient number of unions and flanges to permit the disconnection of sections of reasonable size. On main heating runs, flanges shall be provided at all changes of direction, and on subsidiary lines adjacent to the branch.

In the case of floor ducts, flanges and unions shall be located only in permanently accessible chambers.

All MS pipes cut to length prior to screwing or welding, shall be reamed or filed to full clear bore before fitting. The Contract Administrator shall reserve the right to instruct the Contractor to remove selected sections of pipework to check that this has been done, and should it be found that reaming has not been satisfactorily carried out or that the pipe bore has been in any way restricted, the Contractor shall be required to remove these and all other similar pipes adjacent, until satisfactory conditions are found.

In these cases the Contractor shall at his own expense carry out all removal, reaming and reinstatement work involved.

In the event of pipework having been found satisfactory on initial disconnection, the Contractor shall be reimbursed at the agreed day work rates for all time and material expended in disconnecting and re-fitting.

3.4 Flanges

All flanges used on LPHW are to be to BS EN 1092, 10 Bar pressure. All flanges shall be faced and drilled. The use of flanges to BS 10 1962 shall only be permitted where connections to items of plant dictate their use and in general metric flanges to BS EN 1092 shall be used. Care must be taken to ensure that the correct diameter and length of bolt is used in flanged joints and that only 2 or 3 threads protrude beyond the nut. Cold feed and vent pipes etc. shall have similar gunmetal flanges.

Jointing shall have a minimum thickness of 1.6mm and shall be of a composition suitable for the medium conveyed through the pipe.

On welded assemblies, flanges shall be either smooth bore or welded neck type. In the case of the former, the end of the pipe shall be located approximately 3.2mm short of the face and expanded within the flange.

Flanges of this type shall be welded externally at the boss and internally on the bore.

In plant rooms flanges shall be provided to permit removal of readily portable sections of pipework.

3.5 Copper Tubes & Fittings

Copper tubes shall comply with BS EN 1057.

Fittings for copper tubes shall comply with BS EN 1254, and shall be of the capillary type.

All fittings shall be of the non-dezincifiable variety.

3.6 Pipe Supports & Hangers, etc.

The method of supporting pipework shall be determined by consideration of size, weight, location and neatness.

The design of all pipe supports shall take into account the restraints imposed by the building structure.

Supports shall be designed to allow free expansion and contraction of the pipework and guide brackets shall be installed where necessary to ensure that movement takes place in the required direction. In all cases, care shall be taken to ensure that the axis of the pipe is parallel to that of the support.

Internal pipework shall generally be supported by standard pattern built-in or screw-to- wall Munson Ring pattern pipe clips, or as otherwise directed in the Particular Specification Section.

Before fabricated brackets or hangers are placed in position they shall be painted with an oxide paint.

When used on copper pipework all brackets shall be of gunmetal construction, if steel brackets are used a special packing sleeve shall be fitted to prevent corrosion. When used on galvanised pipework all brackets shall be galvanised. When used on chromium plated pipework, all brackets shall be chromium plated.

Pipework shall be supported at intervals not exceeding the spacing given below and otherwise as directed or found necessary.

Where one bracket or support carries more than one pipe of different size, the spacing of the brackets shall be that specified for the smallest size of pipe.

Maximum Spacing of Supports for Steel Pipework

| Nominal Size of Pipe (mm) | Vertical | Horizontal |
|--------------------------------------|-----------------|-------------------|
| 15 | 2.5m | 1.9m |
| 20 | 2.5m | 1.9m |
| 25 | 3.0m | 2.5m |
| 32 | 3.0m | 2.8m |
| 40 | 3.7m | 3.0m |
| 50 | 3.7m | 3.0m |
| 65 and above | 4.5m | 3.7m |

Maximum Spacing of Supports for Copper Pipework

| Nominal Size of Pipe (mm) | Vertical and Horizontal |
|--------------------------------------|------------------------------------|
| 15 | 1.2m |
| 22 | 1.2m |
| 28 | 1.8m |
| 35 | 2.5m |
| 42 | 2.5m |
| 54 | 2.8m |
| 65 and above | 3.0m |

Plastic pipework shall be supported in line with the manufacturers' recommendations. This is in excess of those outlined above for metal pipework.

Supports shall also be provided adjacent to all valves, cocks and other special components to prevent undue strain on the adjoining pipework and so that components can be removed leaving the adjoining pipework adequately supported at the ends.

The Contractor shall include for the drilling and plugging of walls for fixing all brackets.

Pipework in horizontal ducts shall be supported from stirrup brackets suspended from horizontal MS build-in bearers.

Plastic clip in pipe supports shall NOT be acceptable in any point of the installation.

3.7 Air Venting

All local high points shall be air vented. Fan coil units, radiators, sill line finned elements and air heater batteries shall be provided with integral air cocks, except in cases where they are self-venting into mains.

Pipe lines shall be vented by air bottles with manual operated air cock. Automatic air eliminators should not be used unless agreed prior to installation. Open air pipes shall be used only in locations where they can be carried sufficiently high vertically to overcome the head produced by the pump.

Where air bottles with manual operated air cocks are used, the air cocks are to be installed in the most accessible position available. Where the location permits, such as in plant rooms, a 6mm diameter air discharge pipe shall be run from the air bottle and down on an adjacent wall to terminate at approximately 1500mm above finished floor level with the air cock.

Manual air bottles are to be fed from the same diameter of pipe as they are venting and shall be a minimum of 150mm long or 1.5 times the diameter of the mains, whichever is the greater.

Where space permits and pipework configuration allows, air bottles shall be installed at vertical changes in pipe direction, and always rising vertically above the pipe to be vented.

All automatic air eliminators shall be mounted on small air bottles, the same diameter as the mains which they are to vent and never direct onto the mains. The length of the air bottles shall be a minimum of 100mm or 0.75 times the diameter of the mains, whichever is the greater.

Care must be taken to ensure that automatic air eliminators are only fitted where sufficient room is available for maintenance and replacement. Automatic air eliminators should not be fitted where they are likely to allow ingress of air due to the suction condition.

The automatic air eliminators shall be as Brownall, Type B or similar. A copper discharge pipe shall be taken from the valve external to the building.

Where space permits, a lockshield valve shall be fitted prior to the eliminator to facilitate maintenance without the necessity of draining the system or circuit. The lockshield valve shall be constructed from gunmetal.

3.8 Provision for Expansion & Contraction of Pipework

Adequate provision shall be made for the expansion and contraction of the pipework. Branches from main pipe runs shall be installed so that expansion or contraction can take place without unduly stressing the welds or pipe fittings, and supports shall be designed to allow the correct expansion or contraction of the pipework.

This particularly applies to branches from main pipes running in vertical pipe ducts. Provision for expansion or contraction by means of bends etc. must be made before connecting to the vertical pipes.

Flow and return pipework from the boilers to their respective headers shall be of a suitable length and incorporate at least one right angle bend to prevent the over-stressing of the flanges.

Where expansion or contraction cannot be taken up by changes of direction, mild steel flanged bellows with stainless steel bellows and mild steel protective sleeves shall be provided and installed in strict accordance with the manufacturer's instructions. Expansion bellows shall be suitable for the working and test pressures applicable. In the case of LPG installations, bellows and flexible connections shall be capable of withstanding four times the maximum pressure likely to be encountered in service. Care shall be taken in the installation of such devices to obviate the out-of-line displacement, and the pipework shall be securely supported and guided on both sides of the expansion joint, strictly in accordance with the manufacturer's recommendations.

3.9 Pipe Anchors & Guides

To ensure the correct expansion and contraction of pipework, special mild steel anchor brackets shall be provided where necessary. These anchors shall be rigidly fixed to the structure and be welded or securely clamped to the pipework, to prevent distortion of the pipe runs. The operational loads applied to the building structure by the anchors must be assessed to ensure that the loads can be accepted.

3.10 Pipe Sleeves & Plates

All pipes passing through walls, partitions, floors or ceilings shall be fitted with loose sleeves of the same material as the pipe, except where otherwise directed, cut to length to finish flush with the respective finished surfaces, to permit free movement of the pipework and leave a neat finish.

All pipe sleeves, where exposed to view, shall be fitted with approved chromium plated floor and ceiling plates. These cover plates must not be affixed to the pipes but only to the sleeves or to the building fabric.

3.11 Welding

All welding of steel pipes shall be carried out as follows:

- a) All welding is to be carried out by operatives having a current Engineering I services skill card suitable for the temperatures and pressures incurred on this contract.
- b) All Metallic welding is to be carried out in accordance with BSEN ISO 15610 and the instructions contained in the TR/5 "Code of Practice for Welding of Carbon Steel Pipework for Pressures up to 17 bar and/or Temperatures up to 2200 Centigrade", (hereinafter referred to as the "Code of practice TRI5") published by the Association of Heating, Ventilation and Contractors Association, 34 Place Court, London, W2 4JG.
- c) The Contract Administrator may at his discretion waive or vary the application of the recommended practice, in which case the Contractor shall be informed in writing. If electric arc welding is to be employed, this must be to BS 2971: 1991, and the operatives shall possess current coded certificates to Class 2.

3.12 Welding Inspection

The Contractor shall allow for the cutting out of up to 3% of the welds of positions chosen by the Contract Administrator, for inspection.

Should any of the welds which are cut out prove to be defective, the Contractor shall, at his own expense, cut out and renew such portions or all of the completed welds in the pipe runs from which the defective weld has been cut.

4 Cleaning & Painting

The Contractor shall clean off all dirt, grease and corrosion prior to painting and shall paint as work proceeds, all ferrous supports, channels and other items of the installation. All items of ferrous installation are to be painted with two coat of red oxide primer.

All black tube and fittings should firstly be wire brushed and finished with two coats of red oxide primer, together with a suitable finish coat on exposed pipework as directed in the Particular section of this Specification.

Identification bands to BS 1710 shall be painted or fixed on all services lagged or unlagged at not more than 3.6m intervals and on tees, branches, valves and access panels.

All fan and air handling unit casings, motors, exposed parts of calorifiers, iron valves, supports and brackets in the plant room shall be painted with two coats of flat finish, in addition to the preparation work detailed above. (This shall not include grilles, internal galvanised ductwork or polythene materials in the plant rooms).

All items manufactured from ferrous materials that are exposed to interior conditions or internal situations with a predominantly humid atmosphere shall be firstly treated with two coats of cold galvanising zinc rich epoxy ester primer where the zinc content is not less than 90%. The Contractor shall also include for one coat of the flat finish.

Any remedial work to previously galvanised items shall be treated with two coats of cold galvanising zinc rich epoxy ester primer.

All items manufactured from ferrous materials that are to be installed in areas with a predominantly high humidity or with a high acid or alkaline environment shall be treated with a chlorinated rubber finish.

The Contractor shall follow the recommendations of the paint manufacturer on the suitability of the type and brand chosen before painting is carried out. The paint manufacturer shall be ICI Paints or similar, or as specified in the Particular Specification.

5 Valves, Cocks & Strainers

5.1 General

The standards and types of such valves, strainers and cocks shall be as the specification that follows under the subsequent clause numbers. The valves shall be as manufactured by Herz, Hattersley or Oventrop UK Limited or valves to an equivalent standard.

The valves shall be installed at all places necessary for the proper working, isolation and regulation of the systems and are to be suitable for the working and test pressures for the system in which they are installed, CE marked and comply with the Pressure Equipment Directive 97/23/EC.

In general, for proper regulation of the systems, regulating valves shall be installed in all return pipework connections or sub-circuit pipe distribution networks including HWS secondary circulation pipe distribution.

Regulation valves shall generally be double type as laid down in the particular section of this Specification.

Plug, ball or butterfly valves may be used on gas pipelines. Ball or taper plug type gas cocks shall be used at all plant connections for positive shut off. It shall be the Contractor's responsibility to ensure that whichever type of valve is used, complies with the requirements of the Gas Safety (Installation and use) Regulations and the Institution of Gas Engineers.

Air vents, air bottles and drain cocks shall be installed in accordance with the pipe installation specification and at all other points indicated on the drawings or specified elsewhere within this document.

Three-way vent cocks shall be installed on the open vents serving multiple numbers of boilers and calorifiers. The cocks vent outlet shall be connected to a common vent pipe.

All valves used on domestic water services shall be on the current Water Regulations Guide list of approved fittings.

All valves, stopcocks, draincocks, etc. unless otherwise specified, shall be closed by turning the spindle in a clockwise direction and opened by turning in an anti-clockwise direction.

Isolating valves shall be provided on services to each item of equipment.

Union connections shall be provided adjacent to each valve on the downstream side for all screwed valves where they are not integral with the valve.

Screwed valves shall have heavy hexagon reinforcements at openings, threads of ample length and heavy shoulders to prevent over-entry of pipes or adapters.

Flanged valves shall have the flanges flat faced and of a thickness conforming to appropriate specifications mentioned herein and shall be drilled.

All valves must be made easy to operate before being installed.

Each valve shall have the manufacturer's name or trademark cast or heavily stamped or rolled on. Valves not bearing these distinguishing marks shall be rejected.

On the 'dead' side of all circuit valves, on items of plant and on all low points of the water services systems, 15mm bore drain cocks with hose unions shall be fitted so as to facilitate the draining of all parts of the installation.

Valves on circulating flow mains, branch circuits and 'deadlegs' shall have die cast metal hand wheels with 'open' and 'shut' direction arrows cast on.

5.2 Automatically Controlled Valves

These shall be supplied by the Specialist Automatic Controls firm concerned and designed to operate correctly to the requirements and dictates of the associated automatic control system.

The valves shall be screwed or flanged in accordance with the specification of the pipework into which they are installed.

The valve sizes shall be designed for optimum control at the design service flow. Pipeline reductions to the control valve sizes where required shall be made immediately adjacent to the valve.

Whether or not shown on the drawings isolating valves shall be installed in the pipe connections to each port of the control valves.

A double regulating valve shall be installed in the re-circulation diversion and outlet ports of all three-way mixing or diverting control valves respectively.

Control valve indicators shall be so fixed as to enable position of valves to be easily identified.

5.3 Strainers

Strainers shall be installed immediately prior to all automatic control valves. They shall be the same size as the pipe connections before any reductions immediately adjacent to the control valves and traps.

In general, the strainer elements shall be the manufacturers standard 1/32nd perforated brass type. Other elements of varying degrees of filtration and of stainless steel mesh constructions are available. It shall be the Contractor's responsibility to include for these other elements if any of these are required by the control valve manufacturers for the necessary protection of their equipment

The Contractor shall include for cleaning all strainers twice after the system has been put into operation. The strainers shall generally be of the "Y" pattern before all control valves.

Strainers shall be installed with the basket below the level of the body.

The strainers shall be of the following construction:

| | |
|------------------|---|
| Up to 50mm | Malleable iron screwed dia. |
| 65mm Ø and above | Cast iron with bolted cover and flanged, and drilled in accordance with BS EN 1092 for the test and working pressures and temperatures of the system. |

The strainers shall be as manufactured by Herz, Hattersley or Oventrop UK Limited or equal.

5.4 Isolating Valves

For use with Low Pressure Hot Water (LPHW) heating, Chilled Water and Gas Services.

Valves up to 50mm dia shall be of the inside screw gunmetal wedge disc type gate valves, screwed BS21 and BS EN 10226-1 and manufactured in accordance with BS 5154 and BS EN 12288.

The gate valves shall be complete with non-heat handle, screwed in bonnet, high quality packing and gland, solid wedge disc for rising stem type and hollow disc for non-rising stem type.

Alternatively, the valves shall be full bore ball valves DZR body, PTFE seats and stem seal PN25 at 120°C.

Valves 65mm and above shall be of the inside screw cast iron bronze trim wedge disc type gate valves, manufactured in accordance with the respective BS EN 1171 and BS EN 1092 and flanged and drilled to the appropriate table in accordance with the test and working pressures and temperatures of the system.

These valves shall be complete with malleable iron hand wheels, bolted bonnet and stuffing box, with suitable gasket with one piece glands for 10 bar rating. Wedge discs shall be of cast iron with bronze disc rings rolled

into the cast iron. Discs shall be solid for rising stem type valves and hollow for non-rising stem type. Valve stems shall be manganese bronze and seats shall have shouldered seat rings of bronze screwed into the valve body.

Alternatively, the valves shall be fully lugged Butterfly valves to EN593 SG iron body AISI 420 shaft, CFM8 (316) stainless steel disc and bonded liner.

Valves shall be by Herz, Hattersley or Oventrop UK Limited or similar, suitable for the working temperatures and pressures of the system.

5.5 Double Regulating Valves

For use with Low Pressure Hot Water and Chilled Water Systems.

Valves shall be selected to produce the required 'pressure drop at between 50% and 75% of the fully open position.

Valves up to 50mm Ø shall be bronze, oblique or Y pattern complete with regulating disc having a logarithmic flow characteristic, pressure cocks, position indicator, and reinforced nylon hand wheel end connections screwed BS21 and BS EN 10226-1.

Valves 65mm Ø and above shall be as above but cast iron with bronze trim with flanged end connections to BS EN 1092-2.

The valves shall conform to BS 7350 as supplied by Herz, Hattersley or Oventrop UK Limited or similar suitable for the following maximum working temperatures and pressures indicated. The valves shall also be suitable for isolation purposes.

5.6 Commissioning Sets/Pressure Independent Control Valves

For flow measurement purposes commissioning sets shall comprise of a fixed orifice plate measuring station generally close coupled to a double regulating valve. Measuring stations shall conform to BS7350 and shall be installed with a minimum of five diameters uninterrupted length of straight pipe upstream and typically ten diameters downstream. Measuring stations shall be bronze body up to 50mmØ and stainless steel with cast iron body 65mmØ and above. Test points shall be provided pointing upwards extended to clear insulation.

For water flow rates of 0.041/s or less, low flow measurement units shall be used. Commissioning set orifice plates should be selected for a signal between 70mm and 700mm water pressure.

5.7 Radiators Valves

Valves shall be in accordance with BS2767.

The valves shall have hand wheel on the flow connections and matching lockshields on the return.

All radiators shall be fitted with thermostatic radiator valves.

5.8 Check Valves

Valves up to 50mm diameter shall be the bronze swing type valve screwed BS21 and BS EN 10226-1, with screw on cap.

Valves 65mm diameter and above shall be the flanged cast iron swing type valve complete with sprung solid bronze disc, bronze seating rings and connections flanged in accordance with the actual working temperatures and pressures. All screwed valves shall be to BS 5154 and BS EN 12288 all flanged valves shall be to BS EN 12334.

Valves shall be suitable for the application and installed to the manufacturer's instructions.

The valves shall be by Herz, Hattersley or Oventrop UK Limited or similar.

5.9 Float Operated Valves

All float operated valves and materials shall be WRAS approved.

When installed float operated valves shall be capable of achieving the minimum air gap as required by the Water Supply Regulations.

Ball float valves shall be fitted with a servicing valve on the inlet.

Valves shall be manufactured from cast gunmetal or bronze of a dezincifiable grade.

To prevent back siphonage no connection of a dip tube or silencing pipe to the discharge port shall be permitted. Float valves to WC cisterns shall be fitted with a collapsible silencing tube in compliance with BS 1212-3.

15mm float operated valves shall be of the plastic body diaphragm type to BS 121 unless stated otherwise. Plastic floats shall be to BS 2456.

22mm and above float operated valves shall be the full bore bronze or gunmetal body equilibrium pattern ball float type to BS 1212 with copper float to BS 1968.

5.10 Safety & Relief Valves

Safety to discharge with rapid opening action to prevent pre-determine safe pressure being exceeded. Relief to discharge with opening action proportional to increase in pressure above set pressure.

Safety and relief valves shall meet the requirements of the appropriate British Standard for the equipment to which they are connected and be suitable for the operating conditions of the system. Valve shall be sized for the rated output of the appliance.

Direct acting safety valves shall be in accordance with BS EN 4126-1.

Pipework connections shall be fitted where indicated, to provide discharge connection to safety and relief valves. Discharge and waste pipes shall terminate at visible and safe positions to be agreed with the Contract Administrator. Connections to drains shall be provided as indicated.

Safety and discharge pipework for hot water system shall be laid with a continuous downward gradient. Spring type safety valves.

Valves shall be enclosed spring loaded high lift type.

Valves up to 50mm nominal diameter shall be bronze or DZR copper alloy body as indicated and threaded to BS21 and BS EN 10226-1.

Cast iron valve shall be flanged to BS EN 1092-2.

They shall have a screwed on or bolted on spring casing, carbon steel spring and a gun metal valve head, seat and adjustable screws and ferrule.

Valve shall be complete with a screwed on top cover, testing lever and padlock and shall have a discharge pipe of the same diameter as the valve which shall terminate 300mm from the floor level.

The valve release pressure shall be set at a pressure above the system operating pressure and as agreed with the Contract Administrator. The spring range shall be selected to give equal adjustment either side of the operating pressure.

Valves shall be stamped with their set pressure and limiting temperature.

5.10 Isolating Valves (Portable Water, Hot & Cold Water Services)

15mm to 22mm (Ball Valve Type)

Where stated elsewhere or on the drawings, isolating valves to appliances shall be of the ball valve type.

| | |
|------------------|--|
| Type: | Ball type valve. |
| Body material: | Bronze or DZR copper |
| Pressure rating: | PN25. |
| End connections: | Threaded to BS 21. |
| Specification: | Quarter turn; tight shut-off, chrome plated DZR copper alloy or brass sphere with full bore aperture; PTFE seats and stem seal; anti-blow out stem; WRAS approved. |
| Operation: | Lever operated (in areas where space is limited a T-handle shall be fitted). |

Valves on insulated pipework shall be provided with an extended stem in which the lever is held above the pipeline insulation.

65mm to 300mm (Gate Valves)

| | |
|------------------|---|
| Type: | Gate valve to BS EN 1171. |
| Body material: | Cast iron. |
| Pressure rating: | PN 16. |
| End connections: | Flanged to BS EN 1092-2. |
| Specification: | Wedge disk; non-rising tern; inside screw; cast or malleable iron hand-wheel; BSI Kitemark. |
| Operation: | Hand-wheel operated. |

65mm and above (Butterfly Valves)

| | |
|------------------|---|
| Type: | Butterfly valve to BS EN 593. |
| Body material: | Cast iron. |
| Pressure rating: | PN16. |
| Specification: | Lugged type; WRAS approved EPDM liner; stainless steel shaft; stainless steel disc; WRAS approved: lever and gear operated valves to be complete with long body neck for lagging clearance; good control characteristics. |
| Operation: | Lever operated up to 150mm. Valves 200mm and above shall be complete with gear unit. |

5.11 Check valves (Portable Water, Hot & Cold Water Services)

Check valves shall permit flow in one direction only and close automatically if flow reverses.

15mm to 50mm

| | |
|------------------|------------------------------------|
| Type: | Swing type check valve to BS 5154. |
| Body material: | Gunmetal or bronze. |
| Pressure rating: | PN 25 Series B. |
| End Connections: | Threaded to BS21. |

Specification: Metal disk; screwed in cap; metal to metal seat; WRAS approved; BSI Kitemark; flow direction indication.

Valve shall be suitable for mounting in horizontal and vertical pipe (with vertical flow upwards).

Where specified elsewhere the disc material shall be nitrile rubber but restricted to 90°C maximum temperature and WRAS approved.

5.12 Double Check Valves (Hot & Cold Water Services)

Double check valves where indicated for the purpose of prevention of water contamination by back siphonage, back flow or cross connection shall be top BS 6282-1 and be WRAS approved.

The body material shall be bronze or DZR copper alloy with compression connection to BS EN 1254-2 or threaded to BS 21.

The valve shall be the in-line pattern type, be suitable for vertical or horizontal installation and provide positive closure.

5.13 Stop Valves 15mm – 50mm

Stop taps shall be manufactured in bronze or DZR copper alloy and the washer material shall be suitable for the service fluid and operating temperature. The valve shall be the straight pattern type with connections to suit the services pipeline.

Stop valves for portable water supplies shall be in accordance with BS EN 1213. The valves shall be the straight pattern type manufactured in copper alloy with connection to suit the service pipeline. Valves shall be easy clean polished finish where visible.

5.14 Draw-Off Cocks

15mm - 50mm draw-off cocks shall be the straight type, gland pattern, taper plug, with gunmetal or bronze body, threaded to BS 21 and complete with brass hose union outlet, screwed blank cap and strap. Plugs shall have a square head with a slot to indicate plug position. A loose malleable iron lever shall be provided with each plug valve.

Each draw-off cock shall be hydraulically tested to 20 bar.

5.15 Natural Gas Service Isolation Valves

The installation of valves and cocks shall be as indicated and comply with the recommendation of the IGE.

15mm to 50mm isolating valve

| | |
|------------------|--|
| Type: | Millikan plug valve. |
| Body material: | Cast iron. |
| Pressure rating: | PN 16. |
| End Connections: | Threaded to BS21. |
| Operation: | Wrench. |
| Specification: | Full bore; lubricated parallel plug; self-contained. |

Valves shall be complete with a suitable sealing compound to suit the pipeline service media.

65mm to 200mm isolating valve

| | |
|------------------|--|
| Type: | Plug valve BS 5158. |
| Body material: | Cast iron. |
| Pressure rating: | PN 16. |
| End Connections: | Flanged to BS EN 1092. |
| Operation: | Wrench. |
| Specification: | Full bore; lubricated parallel plug; self-contained. |

Valves shall be complete with a suitable sealing compound to suit the pipeline service media.

5.16 Automatic Gas Shut-Off Valves

Solenoid operated gas shut-off valves shall be provided to automatically isolate the gas as indicated.

Gas shut-off safety valves shall be in accordance with IGE requirements.

Where possible the valves shall be located remote from the areas being protected, provided that the location shall not permit unauthorised interference.

Gas shut-off valves shall comply with BS EN 161 and BS EN 126. Valves shall be electrically operated and arranged to provide a positive shut-off. Valves shall be hand resettable.

Operation and control of gas shut-off valves shall be as indicated elsewhere.

6 Noise and Vibration Control

6.1 General

Background noise, generated by the mechanical installation shall be limited as far as possible by the use of the sound attenuator units in order to achieve the noise ratings specified elsewhere within this Specification.

In addition to the sound attenuator units, it shall be the Contractor's responsibility to provide the necessary equipment to meet the design intent of limiting transmission of noise and vibration due to mechanical plant.

The noise breakout from the mechanical plant and air distribution system shall be controlled to within the limiting background noise ratings for every adjacent area.

Purpose-built attenuators shall be installed within the plant room ductwork of the air distribution systems to control the noise breakout to within the limiting noise ratings.

Attenuators shall be located immediately before penetration of the plant room enclosure.

The Contractor shall check that the material for all subsequent linings, mountings and couplings meets with the approval of the Local Authorities and Building Control Officer.

6.2 External Acoustic Duct Lining

External duct lining where installed shall comprise an inner layer of semi rigid mineral wool or foam slab with an approved layer of hard composition. Sound barrier matting or similar shall also be applied where ductwork has unavoidable large un-stiffened areas. The thickness and density of the duct lining material shall be as required to provide the noise reduction specified.

6.3 Internal Acoustic Duct Lining

External duct lining where installed shall comprise an inner layer of semi rigid mineral wool or foam slab with an approved layer of hard composition. Sound barrier matting or similar shall also be applied where ductwork has unavoidable large un-stiffened areas. The thickness and density of the duct lining material shall be as required to provide the noise reduction specified.

6.4 Anti-Vibration Mountings

General

Vibrating machinery shall be isolated from the building structure with resilient mountings. These mountings shall be designed for a minimum isolating efficiency of 85%, in basement areas. In all roof level and other critically located plant rooms, mounting shall be selected for a minimum isolating efficiency of 95%. Isolation efficiency to be checked by the measurements of acceleration above and below the mounts.

Mountings shall be selected to isolate the lowest forcing frequency of vibration.

Where numbers of resilient mountings are used to support any machine, they shall be selected to have equal deflection.

Particular machines shall be installed as per manufacturer's recommendations unless stated otherwise.

High Pressure Fans

These shall be installed with anti-vibration mountings by using the special bases and mountings mentioned.

| Pressures | Mounting Type |
|------------------|--|
| 0 - 15 mb | Standard channel iron base frame with sprung type mounting. |
| 15 - 25 mb | Inertia black base mounted on spring type isolators in addition to the standard channel iron frame with spring type mountings. |
| Above 25 mb | Base and mounting details shall be submitted to the Engineer for approval. |

Where floating floor isolation is provided, added isolation of inertia bases shall be provided where needed.

Pumps

Anti-vibration mounts apply to direct belt or direct coupled, driven types of pumps. These shall be installed with vibration isolators for the following applications by using the special bases and mountings mentioned. Pumps to be supported in the vertical plane only and should not be directly mounted to the building structure.

Direct and Belt Driven Type Pumps

| | |
|-------------|---|
| Up to 35 kW | Inertia block base installed on rubber impregnated cork mountings. |
| Above 35 kW | Pumps installed on an Inertia block base in turn mounted on spring type AV mountings. |

6.5 Resilient Supports**Pipework**

All pipework over 25mm in diameter which is either in an area of high ambient noise (greater than 65 dBA) or connected to reciprocating machinery shall be resiliently supported. In the former, the resilient supports shall be installed throughout the total pipe length and in the latter, shall be installed for the first 15m or 100 pipe diameters pipe length, whichever is the greater.

The first support shall have the same deflection as the isolators employed on the machinery.

Unless particular supports are detailed, a pipe wrapping of rubber impregnated cork (or other approved) shall be installed between the pipework and its restraints, to prevent noise and vibration transmission.

Ductwork

In plant rooms, ducts shall be supported on flexible hangers with rubber elements, selected bearing in mind any forces exerted during equipment start up.

In other areas, a discontinuity material of rubber impregnated cork or similar shall be used between the ductwork and its supports.

6.6 Flexible Pipe Couplings

At pipework connections to all pumps, neoprene/rubber flexible compensators shall be fitted. Pipework both sides of the compensators is to be firmly supported. These supports are to have clip strips of rubber impregnated cork or similar between the pipe clips and the pipes.

6.7 Sleeves

Where penetrating plant room enclosures, pipework and ductwork shall be decoupled from the structure by fitting a 12mm resilient rubber sleeve around the pipe or duct. The remaining hole shall be infilled with dense grouting material and be made airtight by sealing with a dense pliable non-setting mastic compound.

All services penetrations through fire barriers shall be fire stopped equal to or greater than the fire rating of the barrier.

7 Ductwork**7.1 General**

Ductwork shall be fabricated and installed in accordance with the recommendations of the HVCA as their specifications DW144, DW 154, DW 191, DW 172 and TR/19 as appropriate unless stated otherwise. Copies of the documents shall be kept on site at all times.

Components shall be installed in accordance with manufacturer's recommendations.

Electrical bonding terminals shall be provided as necessary to ensure electrical continuity in accordance with BS 7671 (latest edition of the IEE Wiring Regulations).

Ductwork shall be true in section, correctly aligned, rigid and free from movement, independently supported and free from all contact with the building structure.

Ensure that there are no sharp edges or corners on cut edges on ductwork, flanges and supports. Raw edges on ductwork, formed seams, welds and rivets shall be painted with two coats of zinc rich paint at works and again after erection.

The installer shall be responsible for obtaining all site dimensions and the preparation of drawings as stated elsewhere.

Materials of accessories/components shall be compatible with the ductwork in which they are incorporated and the finishes shall comply with any special requirements. Casing losses of accessories/components shall also be compatible.

Any section of ductwork causing noise due to poor construction shall be removed, corrected and reinstated at no expense to the Contract.

Ensure that long runs of air ducts incorporate the necessary provision for absorbing movement due to expansion or contraction resulting from thermal change.

During installation the installer shall ensure that dust and debris are prevented from entering the ductwork system and that the installation is clean prior to commissioning. Commissioning shall not commence until the cleanliness of the ductwork system has been inspected and certified. The level of cleanliness and protection shall be as defined in HVCA TR/19 and provided to protection, delivery and installation standard PDI Level 2 unless otherwise stated.

Ductwork, fabricated sections and all associated equipment shall be suitable for manual handling where manual handling is unavoidable.

All site storage of materials is to be such that all ductwork is kept clear of dust and debris at all times.

During installation, all open ends are to be covered to prevent the ingress of dirt and debris to the system.

Where open ends are left on site it is the Contractors responsibility to undertake a wet clean in line with DW144 requirements.

7.2 Ductwork Fabrication

Ductwork shall be fabricated to meet the leakage classification in accordance with DW 144 unless stated otherwise.

Internal jointing of ducting shall be avoided wherever possible, but if unavoidable, joints shall be constructed so as to minimise air turbulence at these sections. Approval shall be required before internal jointing is utilised.

Where ducting is exposed ensure that the seams are concealed from view to provide a neat appearance.

An approved liquid or mastic sealant shall be used in all longitudinal and cross joints at works. 'Socket and spigot' and 'cleated' joints made on site, joints shall be applied during or after assembly of the joints to suit.

The use of self-adhesive tape as a primary sealant over both longitudinal and cross joints on air supply and air extract ductwork is not permitted.

Self-tapping screws shall not be permitted unless in circumstances where the use of rivets and nuts and bolts are not practicable.

Edges of galvanised sheets cut to form joints and rivets shall be coated inside and out with zinc rich or aluminium paint. All bolts and nuts shall be of mild steel protected by the electro-galvanising, or sheradising.

All ductwork shall be adequately stiffened, and where necessary braced to prevent drumming or vibration and ducts shall be free from internal sharp edges or projections.

In special cases where internal stiffening is found necessary, these shall be streamlined and details shall be approved by the Contract Administrator.

The use of panel stiffening on rectangular ductwork shall be subject to the approval of the Contract Administrator. Where rigid slab insulation is to be applied to ductwork, plain construction shall only be acceptable.

Ductwork connections to plant and equipment (e.g. heating, cooling coils etc.) shall, in the case of bolted flanges, be provided with matching flanges of similar size and thickness. Sheet metal returned flanges shall not be permitted.

Where connections have transformations with angles in one side to axis more than 25° splitters shall be provided. Splitters shall not obstruct the use of access doors.

Ductwork hangers, bearers and supports shall be to DW144. Supports shall be adjustable for height, spaced to ensure support and where practicable, fitted at each ductwork joint or spaced at not more than the maximum centres in DW 144 for rectangular, circular and flat oval horizontal ducting. Securing of formed brackets to corners of ductwork as a means of suspension shall not be permitted.

Supports to vertical ductwork in building shall be generally located at each floor slab but subject to a maximum spacing of 4 metres.

All ductwork shall be securely supported from the building structure. Approved inert packing material shall be provided between ducts and supports to prevent direct contact of the ducting with the structure.

7.3 Hand Control Dampers

The number and location of hand control dampers shall be in accordance with the latest editions of CIBSE Commissioning Code Series A - Air Distribution and BSRIA AG3 Commissioning air system to facilitate balancing and regulation of the complete and/or part of the system.

Hand control dampers for use on low velocity rectangular ductwork is to be of the stainless steel aerofoil opposed blade control type. For round ductwork only iris style dampers are acceptable.

Low profile aspect ratio aerofoil stainless steel blades shall permit site withdrawal of the complete damper regardless of blade position.

Four to one geared reduction ratio shall provide accurate and sensitive blade positioning and control with minimum torque requirements. Moving parts shall be precision moulded in molybdenum disulphide filled nylon and totally enclosed in the factory fitted externally mounted galvanised steel dust-proof control box, complete with coloured visual blade position indicator and locking wheel.

Damper casing shall be of slim-line airtight dust-proof double skin construction of high rigidity and maximum strength. Casings shall be manufactured from roll formed galvanised 16 gauge steel outer frame and 20 gauge steel inner frame, with the former having continuously welded corners and integral peripheral flanges pre-punched with elongated holes for duct attachment and infinite height adjustment.

The external damper casing surface area shall have a single penetration or drive shaft for control, to simplify insulation and lagging where required.

Dampers suitable for mounting in the vertical or horizontal plane shall be the Air/Shield type as manufactured by Gilberts Limited, Actionair Limited or equal.

7.4 Motorised Dampers

Automatic control dampers shall respond instantly to slight movements of the damper actuators and shall be manufactured to close tolerances to prevent vibration noises. All dampers with dimensions over 1.2m width or 1.8m in height shall be built in two or more sections.

Dampers shall have a flanged casing manufactured from 240mm wide by 50mm deep 20 swg thick steel channel. Each damper section shall have frames of top hat' section 75mm wide overall by 22mm deep x 2.5mm thick. Frames shall be galvanised.

Where volume control is required the dampers shall be fitted with opposed blades. Straight forward shut off dampers shall be fitted with parallel blades. Damper blades shall be made of 16 swg steel with interlocking edges. The maximum permissible blade width shall be 320mm. The blades shall have a galvanised finish. Blade axles shall be manufactured from mild steel and cadmium plated. Interlocking push rods shall be manufactured from zinc plated mild steel. Inter-blade linkage mechanism shall be located internally and all at one side of the damper. Bearings on dampers, i.e. axle, bearings and cross connecting bracket bearings, shall be of Nylatron® which shall be self-lubricating for life and be capable of withstanding temperatures up to 120°C.

Dampers shall be fitted with side seals of spring loaded zero clearance stainless steel and located between the end of the blades and the frame to reduce air leakage in the closed position.

Damper assemblies shall be supplied complete with actuator mounting brackets and linkages. Where necessary, dampers shall be arranged to have thruster units complete with positioners. Thrusters shall be fitted in accessible positions. Access doors shall be provided to all dampers.

7.5 Fire Dampers

Fire dampers shall be provided and installed wherever ductwork systems pass through floors, fire compartment walls and wherever deemed necessary by the Fire Officer or other relevant statutory authority. The complete fire damper assembly shall have a fire resistance rating equal to the fire barrier it penetrates and rated in accordance with BS476.

The fire dampers shall be of the galvanised steel curtain type as manufactured by Gilberts Limited, Actionair Equipment, or equal. All fire dampers shall be complete with 'installation frames' manufactured and installed to HVCA specification and suitable for building into the structure. Fire dampers shall be independently supported from the ductwork such that in the event of a fire and ductwork collapse the fire dampers shall remain in place to maintain the integrity of the fire barrier. Fire dampers shall be installed within the line of the fire barrier, dampers located against or adjacent to the fire barrier shall not be acceptable.

Blades shall not exceed 50mm in width and have rolled edges interlocking to form full length hinges upon which blades pivot when released. The blades shall fold completely upon themselves and be stacked one end of the damper to allow totally unobstructed opening. The blades shall be retained by a fusible link set to operate at 72°C.

The damper frame shall be a continuous channel enclosing the blades and the frame shall act as a continuous stop on both sides of the damper for building into the structure.

All fire dampers shall be fitted with a device which gives visual indication of damper blade position without the necessity for observation of the actual blades or internal duct inspection. The device must be self-contained and not dependant on external electrical or pneumatic services or connections.

Hinged access doors shall be provided as DW 144

The damper shall have the necessary fire resistance when subject to test as stipulated in BS EN 1366-2.

7.6 Flexible Connections

Both inlet and outlet ducting connections shall be isolated from metallic contact with fans of all types and metal ducts shall be arranged so that there is a clear gap of 100mm between the ends of the duct and the fan spigot and the ducts shall be supported close to these gaps so as to remain linked up.

Due observation and implementation of the requirements of all clauses dealing with noise and vibration shall be made in this respect.

Rectangular fan connections fitted with flanges shall be provided with matching flanges drilled and bolted into position as specified, to which shall be riveted a section of ducting to form a 100mm spigot section of identical dimensions to the fan.

At each of these points, a flexible connection shall be made, hemmed and seamed to slip closely over the two spigot ends to which it shall be secured by means of a tightly fitting mild steel flat strap formed in four sections with ends turned back, drilled and bolted so as to draw the band up tightly.

Circular flanged fan connections shall be similarly provided with counter flange and spigot pieces, but the additional pair of flanges outside the flexible joint shall not be required, and clip ends shall be formed in two sections.

The flexible connections shall conform to BS 476 and be from non-flammable neoprene, fibreglass or polyvinyl fabric or other equal materials, with double stitched seam and both edges hemmed. Where connections are made to a builder's work duct, then the necessary counter flange shall be provided.

All ductwork and piping passing through walls or floors and where supported shall be surrounded with a compressible material to avoid contact with the structure. Such packing materials shall be non-flammable, vermin and rot-proof and shall not tend to break up and shall compress sufficiently to prevent transmission of vibration or noise to the structure.

The complete flexible connection assembly shall be capable of withstanding the test and working pressure of the system, and start-up movement/torque of the equipment.

The Contractor shall check that all materials used for flexible connections and packing materials are in accordance with the Local Authorities and Fire officer's approval.

7.7 Test Holes & Plugs

Test holes are to be formed to allow complete testing and commissioning of the system in accordance with BS ISO 580 1 BS 848-1 2007 and shall be suitably plugged in accordance with DW/144 1998 HVCA Specification.

7.8 Access Panels

Purpose-made access panels as manufactured by Gilberts Limited, Actionair or equal are to be installed where required for inspection cleaning, adjustment, calibration and maintenance of all ductwork systems.

7.9 Flexible Ductwork

Flexible ductwork shall be provided for connections between ductwork and terminal units or air diffusers.

Maximum lengths shall be 300mm and all ductwork shall be adequately supported to prevent oscillation and noise generation. Reinforcement in flexible ducts is to be carried over the spigots of the grilles and diffusers and connections to these items are to be painted matt black for the visible depth. Changes of direction shall not be acceptable. An offset of more than 10mm shall not be accepted. No kinking or flattening of the ducting shall be accepted.

Joints shall be made by means of hose type metal clamps which shall tighten around the circumference of the ducting and be finally sealed with 50mm wide plastic adhesive tape.

Flexible ductwork shall be of the insulated type for all supply air ductwork and of the un-insulated type for the return air ductwork, as manufactured by Flexible Ducting Limited, or equal.

8 Thermal Insulation

Acoustic insulation is detailed elsewhere within this Specification.

8.1 References

The materials and methods of application shall conform to the following British Standards:

| | |
|-------------------|--|
| BS EN 13166 2001: | Thermal insulation products for buildings. Factory made products of phenolic foam (PF). Specification. |
| BS 3958 | Part 3:1985, Metal mesh faced man-made mineral fibre mattresses. |
| BS 3958 | Part 4:1982, Bonded pre-formed man-made mineral fibre pipe sections. |
| BS 3958 | Part 5:1986, Specification for bonded man-made mineral fibre slabs. |

BS 5422 2001 - Method for specifying thermal insulating materials on pipes, ductwork and equipment (in the temperature range -40°C to +700°C).

BS 5970 2001 - Code of practice for thermal insulation of pipework and equipment (in the temperature range -100°C to +870°C).

BS 1710 1984 - Specification for identification of pipelines and services.

The fire performance of products is to be tested in accordance with the following:

BS 476 Part 4:1970 (1984) - Non-combustibility tests for materials.

BS 476 Part 6:1989 - Method of test for fire propagation for products.

BS 476 Part 7:1997 - Method for classification of the surface spread of flame for products.

BS ISO 5659 Part 2:2006 Plastics. Smoke generation. Determination of optical density.

8.2 General Requirements

All materials used shall be applied strictly in accordance with manufacturer's recommendations. Refer to manufacturer's application method statement and health and safety information.

The Mechanical Services Contractor shall install proprietary high density phenolic foam load bearing insulation inserts at the bracket/hangers on cold and chilled water lines, refrigerant lines, all external pipework and cold air ductwork.

The Thermal Insulation Contractor shall provide all necessary insulating materials, finishes, adhesives, mechanical supports and fasteners to insulate the installation. Insulation shall be applied by skilled thermal insulation specialist workmen.

Pipes and insulation shall be colour coded as specified in BS 1710 and specified under the clause "Cleaning and Painting", using colours to BS 4800.

Direction of flow arrows in white PVC 25mm wide bands shall be glued to all pipework and ductwork insulation in plant rooms at 5 metre intervals, to be complete with the service descriptions.

No insulation shall be applied until pipes, plant and ductwork have been tested, cleaned and painted and trace heated as specified elsewhere within this Specification. Copper pipework not included in the painting specification shall be cleaned thoroughly to remove all traces of surplus jointing flux, building material dust or debris, moisture and any other foreign matter.

All materials shall be Class 0 as defined in the Building Regulations, Approved Document B (Fire Safety), Appendix A12 when tested in accordance with BS 476: Part 4 or when tested in accordance with BS 476: Parts 6 & 7. This shall also apply to all vapour sealing and other finishes.

It is essential that materials shall not emit smoke or toxic fumes in the event of a fire.

When tested in accordance with BS ISO 5659-2 insulating materials shall achieve a Smoke Obscuration Rating not greater than 5%.

Expanded polystyrene, polyurethane or cork insulation and other thermo-plastics shall not be used as insulating material.

All connections on vessels shall project at least 25mm clear of the finished surface of the insulation.

All insulation shall be supplied with factory applied Class 0 reinforced aluminium foil facing.

All insulation shall have a smooth, homogeneous and lineable finished surface. All rigid sections shall be concentric and be accurately matched for thickness. Steps and undulations in the surface shall not be accepted. No sections or slabs having damaged ends or edges shall be used.

All insulation shall fit tight to the surface to be covered and all slabs and sections shall be butt-up close, butting edges shall be mitred chamfered or shaped as necessary. All joints shall be sealed with matching Class aluminium foil adhesive tape, not less than 50mm wide.

Insulating materials containing asbestos shall not be permitted.

Provision shall be made in valve and flange boxes to accommodate trace heating of the pipework where required.

Insulation applied to vessels and ductwork shall be neatly cut around all manufacturer's name and test pressure plates, tests points and dampers to leave these visible. Lagging shall include the lagging of flanges, joints, expansion bellows and valves unless otherwise specified in the Particular Specification Section.

Calorifier chests and all access manholes or hand-holes shall be fitted with purpose-made removable covers enclosed in a proprietary framed support complete with aluminium foil faced insulation.

External valves and flanges shall be insulated and weather proofed in a similar manner to the pipework.

Access doors in ductwork shall be insulated in a similar manner as the ductwork and be an integral part of the door, and must not restrict the access through or to the door. All edges are to be mechanically protected.

All refrigerant lines, cold and chilled water lines, cold air ducting and all external pipework and ductwork insulation shall be continuous between pipework/ductwork bracket/hangers. The insulation material between such shall be a suitable proprietary high density phenolic foam load bearing insulation inserts abutting the rest of the insulation with the same continuous thickness and vapour/weather-proof finish throughout. (Refer to paragraph 3 - Mechanical Contractor to install load bearing insulation inserts). External pipework installation shall be provided with UV protection to prevent deterioration.

The Contractor shall ensure that all systems operating below dew point conditions shall be suitably protected with vapour seals. The vapour seal shall be continuous and fully sealed at all terminations of and protrusions through the insulation with self-adhesive foil tape or vapour seal mastic.

All materials shall be stored in a suitable manner so as to protect them from damage or deterioration before fixing.

The co-efficient of thermal conductivity (k-values) for each of the materials being supplied for the works, shall be stated if requested by the Contract Administrator and demonstrated by tests on representative samples of each kind of material taken at site and/or maker's works as directed, carried out in accordance with the methods laid down in the British Standard for the material in question.

In the event of the test results not being satisfactory, all unsatisfactory material shall be removed and replaced. In no case shall hard setting composition be considered as contribution to the insulating value.

The Contractor shall ensure that the thickness of insulation is maintained throughout.

Slab insulation of 900mm x 900mm and over shall be held in position by the use of adequately spaced stick clips and washers and set in adhesive.

The Contractor shall ensure that all pipes, plant and ductwork are individually insulated. Wrapping two items together shall not be acceptable.

All thermal insulation materials used shall conform to the following minimum thermal conductivities.

| Mean temperature of insulation under service design conditions | Thermal conductivity (W/m.K) | |
|--|------------------------------|--------------|
| | Phenolic Foam | Mineral Wool |
| 0°C | 0.018 | 0.032 |
| 20°C | 0.018 | 0.034 |
| 40°C | 0.022 | 0.036 |
| 60°C | 0.023 | 0.038 |
| 80°C | 0.025 | 0.040 |
| 100°C | NR* | 0.044 |

*Phenolic foam is suitable for service design temperatures up to 120°C. Therefore, assuming a maximum external surface temperature of 40°C, the maximum mean temperature for phenolic foam insulation is 80°C.

8.3 Insulating Materials

Approved insulating materials meeting the requirements of this specification are as listed below. Equal and approved means materials which have been approved by the Engineer.

8.4 Phenolic Foam Pipe Insulation

Rigid cfc-free "Class 0" phenolic foam, pre-formed bore-coated pipe sections having a nominal density of 35 kg/m³ and thermal conductivity of 0.018 W/m.K at 10°C mean temperature. Supplied complete with factory applied "Bright Class 0" reinforced aluminium foil facing. Kooltherm Pipe Insulation as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

8.5 Phenolic Foam Laminated Slabs

Rigid cfc-free 'Class 0' phenolic foam laminated slabs having a nominal density of 40 kg/m³ and thermal conductivity of 0.018 W/m.K at 10°C mean temperature. Supplied complete with factory applied 'Bright Class 0' reinforced aluminium foil facing. Kooltherm Ductslabs as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

8.6 Load Bearing Phenolic Foam Inserts for Pipe & Duct Supports

Rigid cfc-free 'Class 0' high density phenolic foam purpose designed pre-formed pipe support inserts and duct support strips supplied with factory applied "Bright Class 0" reinforced aluminium foil facing. Kooltherm K-Blocks and Duct Support Strips as manufactured by Kingspan Industrial Insulation Ltd or equal and approved.

8.7 Mineral Wool Pipe Insulation

Rigid bonded "Class O" mineral wool, pre-formed pipe sections having a nominal density of 80 kg/m³ and thermal conductivity of 0.037 W/m.K at 50°C mean temperature. Supplied complete with a factory applied "Bright Class O" reinforced aluminium foil facing. Crown SA Pipe Insulation as manufactured by Owens Corning Alcopor Ltd or equal and approved.

8.8 Mineral Wool Rigid Slabs

Rigid bonded "Class 0" mineral wool slabs having a nominal density of 48 kg/m³ and thermal conductivity of 0.034 W/m.K at 10°C mean temperature. Supplied complete with a factory applied "Bright Class 0" reinforced aluminium foil facing. Crown Rigid Duct Insulation as manufactured by Owens Corning Alcopor Ltd or equal and approved.

8.9 Mineral Wool Flexible Blanket

Flexible bonded "Class 0" mineral wool blanket having a nominal density of 28 kg/m³ and thermal conductivity of 0.034 W/m.K at 10°C mean temperature. Supplied complete with a factory applied "Bright Class 0" reinforced aluminium foil facing. Crown Universal Ductwrap as manufactured by Owens Corning Alcopor Ltd or equal and approved.

8.10 Mineral Wool Lamella Mat

Bonded "Class 0" mineral wool mat having a nominal density of 24 kg/m³ and thermal conductivity of 0.040 W/m.K at 10°C mean temperature. Supplied complete with factory applied "Bright Class 0" reinforced aluminium foil facing. Crown Lamella Mat as manufactured by Owens Corning Alcopor Ltd or equal and approved.

8.11 Insulation Thickness Tables

Thickness of insulation shall be in accordance with BS 5422:2001 as shown in the following tables. The Environmental Thickness tables in BS 5422:2001 are specified by the DETR as the basis of qualification for Enhanced Capital Allowances and as a means of compliance with the Building Regulations, Approved Document L (Conservation of fuel and power).

TABLE 1 Environmental thickness of insulation for non-domestic heating installations to control heat loss. (Reference BS 5422:200 1 - Table 12)

| Steel pipe size size (mm) | | Hot face temperature of installation (°C) | | | | |
|---------------------------------|-----|---|-----------------|------------------|-----------------|----------------------|
| | | +75 | | +100 | | +150 |
| | | Thickness of insulation (mm) | | | | |
| NB | OD | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool | Mineral wool only |
| 15 | 21 | 15 | 30 | 15 | 40 | 50 |
| 20 | 27 | 15 | 40 | 20 | 40 | 60 |
| 25 | 34 | 20 | 40 | 20 | 40 | 60 |
| 32 | 42 | 20 | 40 | 20 | 50 | 65 |
| 40 | 48 | 20 | 40 | 25 | 50 | 65 |
| 50 | 60 | 20 | 40 | 25 | 50 | 65 |
| 65 | 76 | 25 | 40 | 25 | 50 | 75 |
| 80 | 89 | 25 | 50 | 30 | 60 | 75 |
| 100 | 114 | 25 | 50 | 30 | 60 | 75 |
| 150 | 168 | 25 | 50 | 35 | 60 | 75 |
| 200 | 219 | 30 | 50 | 35 | 60 | 80 |
| 250 | 273 | 30 | 50 | 35 | 60 | 80 |
| 300 | 324 | 30 | 50 | 35 | 60 | 80 |
| Vessels and flat surfaces | | 35 | 50 | 40 | 65 | 90 |

TABLE 2 Thickness of insulation for chilled and cold water supplies to prevent condensation on a low emissivity outer surface with ambient air conditions of 25°C and 80% RH. (Reference BS 5422:2001 - Table 8)

| Steel pipe size (mm) | | Temperature of water (°C) | | | | | |
|-------------------------|----|------------------------------|-----------------|------------------|-----------------|------------------|-----------------|
| | | +10 | | +5 | | +0 | |
| | | Thickness of insulation (mm) | | | | | |
| NB | OD | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool |
| 15 | 21 | 15 | 20 | 15 | 25 | 20 | 30 |
| 20 | 27 | 15 | 25 | 15 | 30 | 20 | 40 |
| 25 | 34 | 15 | 25 | 20 | 30 | 25 | 40 |
| 32 | 42 | 15 | 25 | 20 | 30 | 25 | 50 |
| 40 | 48 | 15 | 30 | 20 | 30 | 25 | 50 |
| 50 | 60 | 15 | 30 | 20 | 40 | 25 | 50 |
| 65 | 76 | 20 | 30 | 25 | 40 | 30 | 50 |

| | | | | | | | |
|---------------------------|-----|----|----|----|----|----|----|
| 80 | 89 | 20 | 30 | 25 | 40 | 30 | 50 |
| 100 | 114 | 20 | 30 | 25 | 40 | 30 | 50 |
| 150 | 168 | 20 | 40 | 30 | 50 | 35 | 60 |
| 200 | 219 | 20 | 40 | 30 | 50 | 40 | 60 |
| 250 | 273 | 25 | 40 | 30 | 50 | 40 | 65 |
| 300 | 324 | 25 | 40 | 35 | 60 | 40 | 65 |
| Vessels and flat surfaces | | 30 | 50 | 40 | 65 | 50 | 80 |

TABLE 3 Environmental thickness of insulation for non-domestic hot water services. (Reference BS 5422:2001 - Table 13)

| Steel pipe size (mm) | | Water temperature of 60°C | |
|----------------------|-----|------------------------------|--------------|
| | | Thickness of insulation (mm) | |
| NB | OD | Phenolic foam | Mineral wool |
| 15 | 21 | 15 | 25 |
| 20 | 27 | 15 | 30 |
| 25 | 34 | 20 | 30 |
| 32 | 42 | 20 | 30 |
| 40 | 48 | 20 | 35 |
| 50 | 60 | 20 | 35 |
| 65 | 76 | 25 | 35 |
| 80 | 89 | 25 | 40 |
| 100 | 114 | 25 | 40 |
| 150 | 168 | 30 | 50 |
| 200 | 219 | 30 | 50 |
| 250 | 273 | 30 | 50 |
| 300 | 324 | 30 | 50 |
| Vessels and flat | | 35 | 50 |

TABLE 4 Environmental thickness of insulation for domestic central heating installations (+75°C) and hot water supply systems (60°C) to control heat loss in potentially unheated indoor areas with ambient air temperature of -1°C. (Reference BS 5422:2001 - Table 14)

| Outside diameter of copper pipe (mm) | Water temperature of 60°C/75°C | |
|--------------------------------------|--------------------------------|--------------|
| | Thickness of insulation (mm) | |
| | Phenolic foam | Mineral wool |
| 10 | 15 | 25 |
| 12 | 15 | 25 |
| 15 | 15 | 30 |
| 22 | 20 | 40 |

| | | |
|-----------|----|----|
| 28 | 20 | 40 |
| 35 | 25 | 40 |
| 42 | 25 | 40 |
| 54 | 25 | 50 |
| Cylinders | 35 | 50 |

TABLE 5 Environmental thickness of insulation for ductwork carrying warm air. (Reference BS 5422:2001 - Table 11)

| Temperature difference between air inside ductwork and ambient air (°C) | | | | | |
|---|--------------|---------------|--------------|---------------|--------------|
| 10 | | 25 | | 50 | |
| Environmental thickness of insulation (mm) | | | | | |
| Phenolic foam | Mineral wool | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool |
| 20 | 40 | 25 | 50 | 35 | 65 |

TABLE 6 Thickness of insulation for condensation control on ductwork carrying chilled air in ambient conditions 25°C, 80% rh. for insulation having a low emissivity finish 0.05. (Reference BS 5422:2001 Table 10)

| Minimum air temperature inside the ductwork (°C) | | | | | | | |
|--|--------------|---------------|--------------|---------------|--------------|---------------|--------------|
| 15 | | 10 | | 5 | | 0 | |
| Thickness of insulation (mm) | | | | | | | |
| Phenolic foam | Mineral wool | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool |
| 20 | 30 | 25 | 50 | 40 | 75 | 50 | 100 |

TABLE 7 Minimum thickness of insulation required to give protection against freezing under specified commercial and institutional conditions (Reference BS 5422:2001 - Table 23)

| Initial water temperature | | + 2 °C | | + 2 °C | |
|-----------------------------|------|-------------------------------|--------------|------------------|--------------|
| Minimum ambient temperature | | -6 °C (Indoor unheated areas) | | -10 °C (Outdoor) | |
| Evaluation period | | 12 h | | 12 h | |
| Permitted ice formation | | 50 % | | 50 % | |
| Pipe size (mm) | | Thickness of insulation (mm) | | | |
| O.Dia | Bore | Phenolic foam | Mineral wool | Phenolic foam | Mineral wool |
| Copper pipes | | | | | |
| 15.0 | 13.6 | 23 (25) | 78 (80) | 68 (70) | 413 (420) |
| 22.0 | 20.2 | 10 (15) | 23 (25) | 21 (25) | 58 (60) |
| 28.0 | 26.2 | 7 (15) | 13 (20) | 13 (15) | 28 (30) |
| 35.0 | 32.6 | 5 (15) | 10 (20) | 9 (15) | 18 (20) |

| | | | | | |
|-------------|-------|---------|---------|---------|-----------|
| 42.0 | 39.6 | 4 (15) | 7 (20) | 7 (15) | 13 (20) |
| 54.0 | 51.6 | 3 (15) | 5 (20) | 5 (15) | 9 (20) |
| 76.1 | 73.1 | 2 (15) | 4 (20) | 4 (15) | 6 (20) |
| 108.0 | 105.0 | 2 (15) | 3 (20) | 3 (15) | 4 (20) |
| Steel pipes | | | | | |
| 21.3 | 16.0 | 18 (20) | 48 (50) | 44 (45) | 173 (175) |
| 26.9 | 21.6 | 10 (15) | 21 (25) | 20 (20) | 52 (60) |
| 33.7 | 27.2 | 7 (15) | 14 (20) | 13 (15) | 29 (30) |
| 42.4 | 35.9 | 5 (15) | 9 (20) | 9 (15) | 17 (20) |
| 48.3 | 41.8 | 4 (15) | 7 (20) | 7 (15) | 13 (20) |
| 60.3 | 53.0 | 3 (15) | 6 (20) | 5 (15) | 10 (20) |
| 76.1 | 68.8 | 3 (15) | 4 (20) | 4 (15) | 7 (20) |
| 88.9 | 80.8 | 2 (15) | 4 (20) | 3 (15) | 6 (20) |

Note: Thicknesses given are calculated specifically against the criteria noted in the table. These thicknesses may not satisfy other design requirements. The thicknesses shown in brackets are nearest the standard thicknesses available from manufacturers.

Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing. To provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled circulation of the water and/or trace heating.

Insulation Covering Materials

- Plant Rooms and Service Risers - Aluminium Hammerclad Sheet or Isogenopac.
- Ceiling voids - Reinforced aluminium foil.
- External - Polyisobutylene PIB Sheeting.

9 Provisions for Testing

The Contractor shall make the following provisions as are necessary for the filling, venting, draining and flushing out of the completed section of the installations for the purpose of hydraulic testing.

1. Air release - provide and fix at every high point a 15mm (1/2") screwed boss with temporary air release pipe and air valve brought to hand level. On completion of testing, the air release pipe shall be removed, and a plug substituted, or an automatic air vent fitted.
2. System filling - provide and fix at low points all necessary 20mm (3/4") screwed bosses to allow for filling for hydraulic testing. On completion of testing and draining of the system, drain valves shall be fitted in the bosses.
3. Instrument connections - the Contractor shall provide the following connections throughout the various systems covered by this Specification.
4. 10mm (3/8") plugged bosses on pump suction and discharge connection to accommodate differential pressure gauges.

5. Suitable thermometer wells and pressure gauge cocks on all main and sub-main water circuits flow and returns. Alternatively, the Contractor shall provide and fit, 15mm (1/2") self-sealing test plugs in the appropriate positions, in which case the equipment provided under clauses below shall be of the appropriate type.
6. 10mm (3/8") plugged connection in ductwork on both inlet and outlet of filters, heater and cooling coils, volume control dampers, attenuators and fans for air flow and pressure loss tests.
7. Ammeters to be fitted to each electric motor starter on plant excluding individual room heaters, i.e. fan convectors, unit heaters, etc.
8. Suitable thermometer wells and pressure tappings shall be supplied on the flow and return connections to all items of equipment. Suitable tappings (with valve) for pressure gauges shall be supplied on the pipework for each part of control valves.

Alternatively, the Contractor shall provide and install 15mm self-sealing test plugs in the appropriate positions for the working pressure and type of system.

The Contractor shall supply the following instruments as applicable in connection with the hydraulic and performance tests of the services installation.

VENTILATION PERFORMANCE TESTS

- a) Duct air velocity.
- b) Ammeter.
- c) Tachometer.
- d) Inclined water gauge or air meter with accessories.
- e) Vane anemometer.
- f) Air thermometers.
- g) Thermometers to BS 593 for measurement of flow and return temperatures.
- h) Sling psychrometer.
- i) Stopwatch.
- j) Smoke candles.
- k) Thermohydrograph with test record sheets.

All ventilation test records shall be included on the Record Drawings specified. Location of all test points shall be included.

WATER SERVICES PERFORMANCE TESTS

- a) Ammeter.
- b) Tachometers.
- c) Stop Watch.
- d) Test thermometers suitable for self-seal test plugs or in general to BS 593 Ref B230F1200 x 406 mm long and Ref B14OF.100 as applicable.
- e) Pipe tongs with 32 gauge chromel-constant or thermocouples.
- f) Dial type contact thermometer.

All circuits shall be tested as specified and final results recorded on testing and commissioning record sheets. To be included in the Operation and Maintenance Manuals.

10 Testing

The Contractor shall carry out the complete testing of the works in accordance with the following specification. Pressure testing shall be carried out in accordance with British Code of Practice BS 6880 and BS 5449.

All pipework installations shall be hydraulically tested after erection and before insulation is applied, the test pressure being maintained for two hours unless otherwise stated. For welded mains every weld shall be hammered prior to filling for the pressure test. To facilitate contract progress, these tests may be in sections as all work proceeds. 'Pipework' installations shall include all valves, heat exchangers and controls subject to the system pressure when in commission.

After the particular test pressure is achieved the system shall be immediately sealed by use of a valve and associated test gauge. The test pressurisation unit is then to be disconnected from the system at which time the test period then begins. The test pressure shall then be monitored on the test gauge associated with the sealing valve.

Tests generally shall be twice the normal working pressure, without loss of pressure for a period of at least 2 hours.

The Contractor shall carry out circulation tests as currently recommended in the Commissioning Codes, as published by the Chartered Institute of Building Services Engineers. Before the material or apparatus is despatched from the maker's works, certificates shall be required where specified by the British Standard.

Certified certificates of all such tests shall be provided to the Contract Administrator.

Each item of plant tested at works shall be stamped or fitted with a plate giving:

- a) Normal working conditions.
- b) Test conditions.
- c) Individual equipment number.
- d) BSS number if any.
- e) Date of test.

The above information shall be included on the test certificate for each item of plant, which shall also include location of test and signature of the witness.

In the event of the plant or any section of the installations not passing these prescribed tests, the Contractor shall remedy all faults and the plant, section or sections of contract works shall be retested.

The Contractor shall supervise and carry out on site the following specific tests:

- a) All boilers shall be hydraulically tested after erection, to a minimum of twice the working pressure and maintained for two hours.
- b) All calorifiers shall be hydraulically tested both in battery and shell after erection in accordance with BS 853. Each test shall be maintained for two hours.
- c) After installation, cold water tanks shall be isolated, filled with water to overflow level and be left filled for seven days, after which they shall be inspected for water tightness.
- d) All air moving equipment and plant shall be tested for speed and rotation and for control where differential speed control is incorporated.
- e) All pumps for either liquid, gas or air shall be tested for speed and rotation after installation.

All control systems, electrical, mechanical or hydraulic shall be run through simulated cycles before being put into operation.

10.1 Testing of Ductwork

The Contractor shall be responsible for leak testing of all air distribution systems as installation proceeds in the following manner unless otherwise agreed with the Contract Administrator.

Records of all tests are to be submitted to the Contract Administrator upon satisfactory completion of the tests. For medium and low pressure ducts the Contract Administrator shall select at random a maximum of 10% of the duct system to be tested for air leakage.

All systems served by fans with a design flow rate greater than 1 m³/s and whose pressure class is such that DW 143 recommends ductwork shall be tested for air leakage.

Tests shall be to the pressure recommended in DW 144 and DW 143 for the classification of the selected ductwork.

All high-pressure ducts shall be air leakage tested.

Air leakage testing shall be in accordance with DW 144 and procedures as DW 143 unless otherwise indicated. Tests shall be carried out as the Works proceed and prior to the application of insulation.

In the event of test failure of the randomly selected section, the Contract Administrator shall have the right to select two further sections at random for testing. Where successive failures are identified there shall be the right to require the installer to apply remedial attention to the complete ductwork system and carry re-testing at no cost to the Contract.

Should any air leakage test fail the Contract Administrator shall have the right to instruct the air leakage testing of all medium a low-pressure duct at no additional cost.

The installer shall provide documented evidence of the calculations used to arrive at the allowable loss for the section to be tested. The results of the test shall be witnessed and signed.

On completion of all air leakage testing the installer shall submit a report signed by a competent person confirming the results of the leakage tests.

11 Scouring after Tests

On completion of hydraulic tests, the water shall be released and drained away completely into the nearest drain, using pumping agent plant if necessary; the section afterwards being thoroughly sluiced through to ensure the removal of all dross and dirt.

The Contractor shall inform the Contract Administrator before this operation commences so that the flushing out of the system may be witnessed. After this operation, a certificate must be submitted to the Contract Administrator and recorded in the Operating and Maintenance manuals. The whole system shall be flushed out twice, the second time with hosed water supply make up at high points.

After scouring, the Contractor shall ensure that all scale pockets, drain points, strainers, etc. are completely cleared before the various services are put into commission.

Where pipe circuits include motorised valves, heater and cooler batteries and heat exchangers, the Contractor shall include for the services of a Specialist Contractor for proprietary cleaning of the system.

12 Commissioning

12.1 General Requirements

This section of the specification identifies general testing and commissioning requirements applicable to all services and sections within this specification. The process is summarised in the flow chart appended to section this section.

12.2 Definitions

Commissioning – The advancement of an installation from the state of static completion to full working order to the specified requirements. It includes the setting to work of an installation, the regulation of the system and the fine tuning of the system.

Commissioning Specialist – The firm (or person) appointed by the Mechanical Contractor to carry out specified duties in connection with commissioning engineering services in accordance with the commissioning specification. The Commissioning Specialist shall be someone with relevant training and experience who is either a member of the Commissioning Specialists Association or The Commissioning Group of the HVCA.

Commissioning Manager - The person belonging to or appointed by the Commissioning Specialist to manage the commissioning process, being responsible for overall planning, supervision and witnessing of the results of the integrated commissioning of all installed building services.

Verification Specialist - The firm (or person) appointed by the Mechanical Contractor to verify the results recorded by the Commissioning Specialist.

Commissioning Management Organisation (CMO) - The firm (or person) appointed by the Main Contractor to manage the commissioning process, being responsible for overall planning, supervision and witnessing of the results of the integrated commissioning of all installed building services.

Engineer – The Mechanical and Electrical Engineering Design Consultant (CPW)

Controls Specialist – The firm appointed by the Mechanical Contractor to design, install, set to work and commission the automatic controls or Building Energy Management systems (BEMS/BMS) For all other definitions refer to the relevant CIBSE Commissioning Codes.

12.3 Reference to Other Design Documents

This section of the specification shall not be read in isolation. It must be read in conjunction with the other sections of this specification, the drawings and other documents referred to therein. The Mechanical Contractor is to ensure that his Commissioning Specialist has access to all of these and any other relevant documents during the tender and afterwards in the following construction phases.

12.4 Standards Applicable

The Commissioning Specialist shall follow all relevant industry accepted good practice guides and standards. These shall include but not necessarily be limited to the following:-

| Standards & Guides | | |
|--------------------|----------------------|---|
| CIBSE | Commissioning Code A | Air Distribution Systems |
| CIBSE | Commissioning Code B | Boiler Plant |
| CIBSE | Commissioning Code C | Automatic Controls |
| CIBSE | Commissioning Code W | Water Distribution Systems |
| CIBSE | Commissioning Code L | Lighting |
| CIBSE | Commissioning Code M | Commissioning Management |
| CIBSE | Guides | Building Services |
| CIBSE | TM1 | Building Logbook |
| BSRIA | AG1/91 | Commissioning of VAV systems in Buildings |
| BSRIA | AG1/2001 | Pre-commissioning and Cleaning of Pipework Systems |
| BSRIA | AG3/89 | Commissioning Air Systems |
| BSRIA | AG5/2002 | Commissioning Management |
| BSRIA | AG2/89 | Commissioning Water Systems |
| BSRIA | TM1/88 | Commissioning HVAC Systems |
| BSRIA | AG16/2002 | Variable Flow Water Systems |
| BSRIA | AG20/95 | Commissioning of Pipework Systems |
| CSA | TM/5 | Health & Safety Legislation Affecting Commissioning |

The above standards and guides are continually being update, with new standards becoming applicable. The Mechanical Contractor shall ensure that the Commissioning Specialist is familiar with the latest standards applicable at Tender and completes all works in accordance with these standards.

12.5 Scope of Work

The Mechanical Contractor shall allow for a named, suitably qualified, Commissioning Specialist to undertake all commissioning work as detailed in this Specification and as follows: -

1. All management and advice activities during design, installation, pre-commissioning, commissioning and verification stages of the project. The management activities shall be compliant with the guidance given in the CIBSE Commissioning Code M and BSRIA AG5. The commissioning activities shall be fully integrated into the construction process from the point of appointment of the Mechanical Contractor, right through handover and beyond to fine tuning the building services during occupation. Appointing the Commissioning Specialist part way through the construction phase will not be tolerated.
2. Early involvement in the project to advise on the commissionability of the building services design, whether that design is by the Engineer or the Mechanical Contractor. It is essential that this activity is undertaken in a timely manner to ensure that the systems can be commissioned satisfactorily without delay or additional cost.
3. Oversee all pre-commissioning activities carried out by the installers as prescribed in the aforementioned commissioning guides and as specified in this and other sections of the specification and drawings. This includes overseeing and verifying the commissioning activities of specialist plant items such as chillers, boilers, DX cooling systems, BEMs etc. which are often specialised in nature and are commissioned by the Manufacturer. The commissioning of specialist equipment, such as those aforementioned, especially where they integrate with the air and water distribution systems shall require careful consideration and integration within the commissioning plan. The Mechanical Contractor and the Commissioning Specialist shall agree any divisions of responsibility to fully appreciate their respective scopes of work.
4. All physical works involved in all commissioning activities including setting to work and dynamic proving in order to achieve the design intent. This includes returning to site for balancing and regulation adjustments

during the maintenance period. Performance tests on heating and air conditioning systems shall be undertaken in peak weather conditions, irrespective of when completion takes place.

5. Demonstration to the Engineer, of a proportion of final system flow rates.
6. Provision of all necessary documentation including test records, commentary, diagrams, and reports for Contractor's manuals.
7. Give notice to the Building Control Body or Local Authority declaring that a commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard; and the results of the tests confirm that the performance is reasonably in accordance with actual building designs, including written commentaries where excursions are proposed to be accepted.

The Mechanical Contractor shall allow for all costs associated with the above and the foregoing being included within his tender price. It should be noted that it is the Mechanical Contractor's responsibility to ensure that the Commissioning Specialist has viewed all tender documents and outline programme during tender stage to ensure that all necessary costs from his Commissioning Specialist have been included. The Mechanical Contractor shall also include for all fees charged by the Nominated or other Insurance Companies for all supervision and examination at the manufacturers' works during construction of all pressure vessels and similar equipment and the witnessing of works tests in addition to site tests and the incidental work involved. Two copies of all test certificates shall be supplied to the Commissioning Specialist.

The scope of scope of work, divisions of responsibility and the stage at which the commissioning activities should be undertaken is summarised in the appendix towards the end of this section in a flow diagram. The Contractor, the Mechanical Sub Contractor and the Controls Specialist shall comply with these divisions of responsibility unless specified otherwise within the particular part of this specification or agreed in writing with the Engineer.

12.6 Commissioning Specialist

All commissioning works detailed in this Specification and in particular this section of the Specification shall be commissioned by one of the following Commissioning Specialists. No other companies will be accepted for this work under any circumstances.

| Commissioning Specialists | |
|---|--|
| Airtech Commissioning Tel No. 0121 415 4141 | Eurocom Tel No. 01922 701194 |
| Central Commissioning Tel No 01727 251 378 | Comtech Tel No. 0208 668 0312 |
| Bromley & Owen Tel No. 01487 814575 | Cardiff Commissioning Ltd Tel No. 02920 521111 |

12.7 Commissioning Management

Unless specified otherwise, the Commissioning Specialist shall manage his own activities, establish clear lines of communication and be responsible for ensuring the commissioning is completed in accordance with this specification and the agreed programme. For some large or complex projects it may be necessary for the Main or Principal Contractor to employ a CMO. Should this be necessary then the Commissioning Specialist would be informed of this intention within the specific section of the specification under the heading "COMMISSIONING MANAGEMENT" or similar.

12.8 Health & Safety

The Commissioning Specialist has a duty under the Construction Design and Management Regulations to review the commissioning plan and bring any safety matters to the attention of the Principal Contractor. Any actions resulting from this Health and Safety review shall be confirmed and managed by the Principal Contractor prior to any commissioning work being undertaken. The Commissioning Specialist should be aware of the general risks associated with building services and be Section SEVEN(C) Commissioning Job No: 15007 cpwp.com 5 conversant with applicable legislation. Reference should be made to CSA TM/5 Health & Safety Legislation Affecting Commissioning and the Safety sections contained within the relevant commissioning codes.

12.9 Witness and Verification

Witnessing and verification of tests will be required to enable confidence to be established for the commissioning results. Unless specified otherwise, the witnessing and verification will be undertaken by a Verification Specialist, independent of the Commissioning Specialist and appointed by the Mechanical Contractor. The Commissioning Specialist shall also allow for a proportion of tests to be witnessed by the Engineer. The proportion of tests to be witnessed by the Engineer will be 20%, though this could be reduced to 10% at the discretion of the Engineer on very large systems. The Engineer has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful. In this instance the Mechanical Contractor shall bare all additional costs associated with this additional work. The Commissioning Specialist shall inform the Engineer of the verification programme who shall at his discretion invite the Client representative. The Commissioning Specialist shall obtain counter signatures on all commissioning sheets to obtain certification that the results are within tolerance. No re-writing of test sheets shall be permitted following witnessing by the Verification Specialist or the Engineer. The commissioning specialist shall witness and verify 100% BMS and controls hardware and software function, integration and performance

12.10 Testing and Pre-commissioning

The Mechanical Contractor shall define and agree with the Engineer the responsibility for testing and pre-commissioning activities, i.e. whether the installer or the Commissioning Specialist is undertaking the activities. In some cases the installer would undertake these activities and in this case the Commissioning Specialist shall adopt an overseeing role to ensure the test results are satisfactory and all the pre-commissioning checks have been undertaken, documented and any remedial activities are undertaken to the satisfaction of the Engineer. Reference shall be made to all other sections of this specification, the flow chart in the Appendix and the drawings to fully understand the scope of the overseeing role.

12.11 Compliance with Part L of the Building Regulations

Part L of the Building Regulations is concerned with the conservation of fuel and power. All works approved under Part L of the Building Regulations are required to be commissioned in accordance with the design intent. This applies to heating ventilation, cooling/refrigeration, lighting, controls and hot and cold water systems. The Commissioning Specialist shall ensure that he is conversant with the Regulations and in particular the criterion which deals with the commissioning of the building services. The Commissioning Specialist shall ensure that he follows the guidance given in the approved procedure. The approved procedure is described in HVCA DW/143 - Air Leakage Testing of Ductwork and CIBSE Commissioning Code M – Commissioning Management. He shall also provide a written notice to the Building Control Body that should include a declaration confirming that:

- 1) The commissioning plan has been followed so that every system has been inspected and commissioned in an appropriate sequence and to a reasonable standard; and
- 2) The results of tests confirm that the performance is reasonably in accordance with the actual building designs, including written commentaries where excursions are proposed to be accepted.

12.12 Building Logbook

A Building Logbook is required under Part L of the Building Regulations to ensure that the building uses no more power than is reasonable. The Main Contractor shall be responsible for the compilation and timely issue of this document to the building owner/client to enable him to manage the building's energy from the date of

practical completion.

The Commissioning Specialist shall be responsible for the preparation, completion and timely handover of key elements of this document to the Mechanical Contractor. These include but are not limited to:

- 1) Commissioning, handover and compliance
- 2) Metering, monitoring and targeting strategy
- 3) Building energy performance records
- 4) Relevant compliance and test certificates

It is essential that the Commissioning Specialist is conversant with the standard logbook template so he can provide the right level of information in the correct standard format and in a timely manner.

The Mechanical Contractor shall coordinate and obtain all other information necessary to complete the mechanical and electrical elements of the logbook. This includes but is not limited to obtaining information from the Engineer/Design Team, the Electrical Contractor and the Builder or Main Contractor. This must be programmed in and completed in advance of practical completion. The Logbook shall follow the standard format described within CIBSE TM31 and the guidance from the Carbon Trust which is illustrated within a CD as part of TM31. All information supplied to be incorporated within the logbook shall be provided both electronically and in hard copy. The logbook shall make reference to other documents such as the O&M manual and the Health & Safety File. The completed logbook shall be issued in hard and electronic versions so that as a living document it can be amended easily at a later date should it be required. It must be issued to the Main Contractor and Engineer for approval at least 2 weeks before practical completion.

12.13 Commissioning Programme

The Commissioning Specialist shall produce a detailed commissioning programme which shall be fully integrated into the main contract construction programme. The commissioning programme shall be developed at the same time as the installation programme to ensure that the requirements for commissioning are incorporated in the construction activities.

Section SEVEN(C) Commissioning Job No: 15007 cpwp.com 6 The commissioning programme shall be broken down into individual services including sub contract works and shall include but not be limited to the following tasks:-

- 1) Review design drawings and specifications for commissioning requirements (commissionability),
- 2) Review installation drawings and technical submissions for commissioning requirements,
- 3) Review the installation for compliance with specifications and drawings intent for commissioning,
- 4) Produce detailed commissioning method statements,
- 5) Testing and pre-commissioning,
- 6) Off-site testing of plant items,
- 7) Pipework system cleaning and dosing,
- 8) Pressure testing of ductwork where applicable,
- 9) Setting to work of plant systems and commissioning and performance testing,
- 10) Open system scans
- 11) Demonstration of flowrates to the verification specialist and engineer,
- 12) Soak tests
- 13) Prepare testing and commissioning reports,
- 14) Statutory demonstrations of life safety systems, to building end user and statutory authorities,
- 15) Prepare and complete the relevant sections of the building logbook,
- 16) Prepare final record documentation,
- 17) Prepare and submit the commissioning completeness notice to building control,
- 18) Training and awareness sessions with the building owner/user.

The commissioning activities shall be fully co-ordinated within the programme by the Commissioning Specialist. The Commissioning Specialist shall indicate the resourcing requirements within the programme tasks. The programme shall show critical activities and milestones to enable focus to be maintained on these items in order to minimise the risk of delay. The commissioning programme shall be submitted to the Engineer no later than 6 weeks after the date of contract commencement, for approval. The dates involved will be kept within the periods originally computed for testing and subsequently inserted as part of the 'Programme of Works'. Following completion and approval of this programme the Commissioning Specialist shall review the programme in relation to the construction progress at the regular site attendance meetings. The testing will proceed on the dates given but not less than 14 days following the notification to the Engineers of the state of readiness.

All Specialist Sub-Contractors and Specialist Suppliers to the Mechanical Contractor must note that they shall attend promptly on the times and dates stated. Failure to do so will result in the Schedule being extended and any parties failing to attend will be responsible for reimbursing the other parties involved for loss of time.

Notification of the testing programme commencement will not be less than 14 days and no cancellations will be allowed.

12.14 Design Familiarisation

Immediately following appointment and prior to works commencing on site the Commissioning Specialist shall:

- 1) Inspect the design drawings and this Specification in order to fully familiarise himself with all the engineering services to be commissioned.
- 2) Be fully satisfied that all necessary provision has been made for commissioning of the services including items such as volume control dampers, commissioning stations and pressure stabilising valves.
- 3) The Commissioning Specialist shall issue a report to the Engineer to include:
 - a) The details of any additional items that the Commissioning Specialist considers should be included.
 - b) Any further information needed to complete the installation.
 - c) Detailed testing and commissioning program for the works.

12.15 Contractors Working Drawings

Prior to submission of any Mechanical Contractors working drawings to the Engineer for approval, the Commissioning Specialist shall verify each drawing for commissionability, this shall include:

- 1) Correct positioning and accessibility of all controls, detectors, valves, dampers, items of equipment.
- 2) Correct location and orientation of ductwork access panels.
- 3) Indicate on all ductwork drawings the position of all test holes required.
- 4) When each drawing has been verified it shall be signed off by the Commissioning Specialist as being acceptable to him to enable commissioning to be undertaken and correct dynamic operation.
- 5) Note that the Commissioning Specialist shall comment and verify only. The provision of such above drawings (except marking of test holes) shall be by the Mechanical Contractor who shall allow all necessary costs.

12.16 Site Meetings to Be Initiated

The Commissioning Specialist shall be required to attend monthly meetings from Contract Commencement to report on all stages of the commissioning, from initial planning/programming through to contract completion.

Section SEVEN(C) Commissioning Job No: 15007 cpwp.com 7 Two weeks prior to the first pre-commissioning activity the Commissioning Specialist will be required to commence attending weekly commissioning meetings, to report on the status of the commissioning, through to contract completion. The frequency of these meetings will be determined by the Engineer but the Contractor shall allow for weekly attendance.

The meetings shall be chaired by the Commissioning Specialist and the Mechanical Sub-Contractor shall attend with all his major Sub-Contractors.

The Engineer will not be present at any of these meetings but shall receive minutes of the same issued by the Commissioning Specialist.

12.17 Review Site Visits

During the installation of the contract works the Commissioning Specialist and the Mechanical Contractor shall visit site on a minimum basis of every two weeks to monitor the commissionability of every aspect of the services detailed in this Specification. This shall include ensuring that all commissioning stations are installed in accordance with the manufacturer's instructions and, all other items are installed in accordance with the approved working drawings and are fully accessible.

Any aspect of non-compliance with the above shall be reported in writing to the Mechanical Contractor who shall carry out the necessary remedial work. Copies of all reports shall be issued to the Engineer.

During the site visits the Commissioning Specialist shall carry out an audit of static testing of services to ensure that this work is being carried out satisfactorily. A written log of all static tests audited shall be kept for inspection by the Engineer.

As a part of the on site inspections the Commissioning Specialist shall ascertain that all aspects of the services can be fully maintained after handover. A report shall be issued to the Mechanical Contractor detailing any item that cannot be fully maintained and a copy of the report shall be issued to the Engineer.

12.18 Commissioning Records & Test Sheets

The commissioning specialist shall ensure that accurate records are taken for all checks and measurements undertaken within the commissioning scope of works. The records shall be completed at the time of undertaking the commissioning activity and should include any additional commentary that will support the understanding of the results, either later in the commissioning programme, or in the future after the building has been in operation for some time. It is essential that this anecdotal information is included as it will help future fine tuning of the services and enable informed decisions to be made during building modifications and improvements.

Standard commissioning pro forma checklists shall be used to record the results. These shall be based on the criteria and templates in the relevant BSRIA Application Guides listed earlier in this specification. The Commissioning Specialist shall issue the proposed pro formas to the Engineer for approval prior to undertaking any testing. The completion of these pro formas should be completed only once (i.e. not subsequently transcribed by typing since this can lead to errors being introduced).

The design of the pro forma shall be well thought out in order to:-

- 1) Aid the efficient execution of the commissioning tasks.
- 2) Help the control of quality and progress of the commissioning tasks.
- 3) Provide a convenient means of comparing test results within design values.
- 4) Serve as a permanent record of commissioning data to be included in the project's operating and maintenance manual.

12.19 Formal Stage Gate Reports

The Commissioning Specialist shall produce formal written reports at the following seven Stage Gates.

Progression from one commissioning stage to the next will only be allowed following the successful completion and sign off of the preceding stage. Completion of a stage shall be formalised by a Stage Gate Report, produced and signed by the Commissioning Specialist, with counter signatures by the Mechanical Contractor and the Engineer. The stage gate shall be considered 'closed' until the signed off report is issued and duly accepted by the client and his design team.

- 1) Pre-construction-design is commissionable
- 2) Installation is acceptable Pre Commissioning
- 3) Final coordination of all commissioning reports
- 4) Setting to work and Open System Scans
- 5) Regulation and balancing – System Commissioned
- 6) Operation and demonstration

The report should have an executive summary indicating whether the system is compliant or not at that point and if not what follow up action is required. Pro forma checklists as described above shall be appended to the report to record all the checks and comments made. The reports shall be issued to the Engineer and the Mechanical Contractor at the earliest opportunity for their comment.

12.20 Calibration of Instruments

The successful Commissioning Specialist must ensure that the instruments used have been correctly calibrated and produce documentation to this effect. Calibration must be carried out against laboratory standards which are either traceable to National Standards or have been derived by approved ratio techniques.

The calibration certificates should include the following details:

- 1) Name of Calibration Laboratory.
- 2) Name of Equipment Manufacturer.
- 3) Equipment Model.
- 4) Serial Number of Equipment Being Calibrated.
- 5) Date of Manufacturer.
- 6) Date of Calibration.
- 7) Period of Validity of Calibration i.e. date for next re-calibration.
- 8) Deviation table where applicable.

If the Engineer has any doubt about the accuracy of any instrument, the Commissioning Specialist must have the instrument re-calibrated by a recognised Specialist.

A current calibration certificate shall be provided for all instruments used during the commissioning. The certificate must cover the duration for which the instrument is used.

12.21 Method Statements

The Commissioning Specialist and the Mechanical Contractor shall be responsible for compiling detailed commissioning method statements for all systems detailed in this Specification, this shall include obtaining method statements from all Commissioning Specialists and all suppliers of plant and equipment being installed on this contract, and amalgamating them into an overall method statement to provide a fully co-ordinated document for each service (including controls).

The document shall be sectionalised for each system to clearly indicate the work which will be carried out for pre-commissioning, commissioning and performance testing

12.22 Inspection of Materials

The Engineer shall be entitled at all reasonable times during the manufacture, to inspect, examine and test the materials and workmanship of all plant to be supplied under this Specification and if part of the said plant is being manufactured on other premises, the Mechanical Contractor shall obtain permission to inspect, examine and test as if the said plant were being manufactured on the Mechanical Contractor's premises.

Such inspection, examination or testing if made shall not absolve the Mechanical Contractor or release him from any obligation under this Specification.

Written notice shall be given to the Engineer of the date on which, and the place at which any plant will be ready for testing, and unless the Engineer shall attend at the place named within 10 days of the date which has been stated in his notice, tests may proceed which shall be deemed to have been made in the Engineer's presence, and the Mechanical Contractor shall forthwith forward to the Engineer duly certified copies of the test reading. The Engineer shall give twenty-four hours notice in writing of his intention to attend the tests. Such tests shall however, normally be attended solely by the Mechanical Contractor and his Commissioning Specialist.

Where the Specification provides for tests at outside premises, the Mechanical Contractor, except where otherwise specified, shall provide free of charge, such assistance, labour, materials, electricity, fuel, stores, oils and grease specified by the manufacturers, apparatus and instruments as may be required and as may be reasonable to carry out such tests efficiently.

If, after inspecting, examining, or testing the plant, the Engineer shall decide that such plant or any part thereof, is defective, and not in accordance with the Specification, he may reject the said plant or any part thereof by giving, within reasonable time, notice in writing of such rejection stating therein the ground upon which the said decision is based. Normally the Commissioning Specialist shall filter out and resolve such problems without recourse to ask for advice from the Engineer.

At the commissioning and practical completion time of the Contract, all moving parts shall be adjusted and lubricated in accordance with the manufacturers' instructions, including the filling of oil wells, greasing of bearings, adjustment of belts, alignment of couplings, etc.

12.23 Flushing and Chemical Cleaning

The Commissioning Specialist shall be responsible for ensuring that all pipework is flushed and chemically cleaned by others as detailed elsewhere in this Specification. The Commissioning Specialist shall supervise the flushing and cleaning of all services and be satisfied that all work is being carried out in accordance with the relevant governing documents, BSRIA Application Guide AG1/2001 - Pre-commissioning and Cleaning of Pipework Systems and this Specification. The Commissioning Specialist shall issue a report to the Mechanical Contractor detailing any non-compliance with the above and a copy of the report shall be issued to the Engineer.

12.24 Tolerances

All systems should be regulated to tolerance bands to ensure that they meet the design intent.

Systems shall be commissioned in accordance with the tolerances detailed in the following table except where more stringent requirements are detailed in the specific sections of this specification / drawings. Where a tolerance is not defined in the Tender documents the levels within the CIBSE commissioning codes shall be used for tender and confirmed with the Engineer before commencing work. Should the Commissioning Specialist be unclear of the performance effect (Low, Med, High) of the systems within this specification then

he shall seek advice from the Engineer.

For most heating and chilled water applications, the Performance Effect shall be considered as Medium and the tolerances are summarised in the table below. For close control air-conditioning the performance effect is High.

On the air side, for general comfort cooling and ventilation systems, the performance effect shall be considered as Low. For full air-conditioning and pressurisation systems the performance effect is Medium and for close control air-condition the cpwp.com 9 performance effect is High. The Commissioning Specialist shall consult the Engineer about acceptable tolerances for special process applications prior to the completion of the Mechanical Contractor's working drawings.

For a proportional balance to be achieved on water systems, the upper and lower tolerance levels should not be exceeded. The index leg shall not be less than the minimum value and the remainder of the proportional balance should be achieved within the overall tolerance and should aggregate to at least 100%.

The following table shows permissible tolerances for the most common applications for water and air systems. The Commissioning Codes W & A should be referred to for all other applications. This table is to be read along with the associated notes and conditions of use within those Codes.

| Commissioning Tolerances | | |
|---|--|---|
| Component Description | | Flow Rate Tolerance (% Design) |
| LTHW heating systems where flow / return temperature difference $\geq 11^{\circ}\text{C}$, performance effect Medium. | Terminal units where flow rate <0.1 l/s (e.g. rads & FCU's) | 90 – 100% |
| | AHU coils where flow rate >0.1 l/s | 92.5 – 107.5% |
| | Branches | 92.5 – 107.5% |
| | Mains | 100 – 110% |
| Chilled water systems where flow / return temperature difference $\geq 11^{\circ}\text{C}$, performance effect Medium. | Terminal units where flow rate <0.1 l/s (e.g. FCU's & chilled beams) | 95 – 110% |
| | AHU coils where flow rate >0.1 l/s | 100 – 110% |
| | Branches | 100 – 110% |
| | Mains | 100 – 110% |
| Air flow for general mechanical ventilation | Terminals | 95 – 115% |
| | Branches | 95 – 110% |
| | Main Duct | 95 – 110% |
| Air flow for air conditioning systems | Terminals | 100 – 110% |
| | Branches | 100 – 110% |
| | Main Duct | 100 – 110% |
| Air flow for close control, safety and fume exhaust systems | Terminals | 100 – 105% |
| | Branches | 100 – 105% |
| | Main Duct | 100 – 105% |

12.25 Pressure Testing

The Mechanical Contractor and his Specialist Sub Contractors shall undertake hydraulic and or pneumatic pressure testing of pipework in accordance with the relevant standards and this Specification. The Commissioning Specialist shall review the testing method, check instrument calibration, witness the test and counter sign the test certificates. The Commissioning Specialist shall inform the Mechanical Sub Contractor and the Engineer of any test failures. Following a test failure he shall monitor the progress of any remedial work and the subsequent pressure tests until a satisfactory result is achieved.

12.26 Commissioning of Equipment by Manufacturers

Specialist plant and equipment shall be inspected / commissioned by the manufacturer's competent person and a full commissioning report provided and included in the O&M documentation. The following plant shall be commissioned by the manufacturer:

- 1) All variable speed pumps.
- 2) Air handling units.
- 3) Chillers.
- 4) Boilers.
- 5) Biomass boiler package including fuel storage and conveying systems.
- 6) Gas fired radiant heating.
- 7) Water treatment plant.
- 8) Packaged domestic hot water generators.
- 9) Refrigeration systems and heat pumps.
- 10) Compressed air plant.
- 11) CHP plant.
- 12) Booster sets.
- 13) Automatic controls and BEM's.

The Commissioning Specialist shall include the commissioning period of all specialist plant and equipment within his plan and ensure that the coordination and timing of these activities fits in with the main commissioning programme and ultimately the construction programme. The Commissioning Specialist shall obtain the commissioning report and verify that all the checks have been completed and signed off, with the system being safe, prior to setting them to work as part of the overall building services systems.

The Mechanical Contractor shall inform the Commissioning Specialist of the divisions of responsibility between specialist plant manufacturers and the Commissioning Specialist when it comes to commissioning that plant.

12.27 Open System Scan

The Commissioning Specialist shall include the commissioning period of all specialist plant and equipment within his plan and ensure that the coordination and timing of these activities fits in with the main commissioning programme and ultimately the construction programme. The Commissioning Specialist shall obtain the commissioning report and verify that all the checks have been completed and signed off, with the system being safe, prior to setting them to work as part of the overall building services systems. Section SEVEN(C) Commissioning Job No: 15007 cpwp.com 10 The Mechanical Contractor shall inform the Commissioning Specialist of the divisions of responsibility between specialist plant manufacturers and the Commissioning Specialist when it comes to commissioning that plant.

12.28 Documentation for Operating and Maintenance Manuals

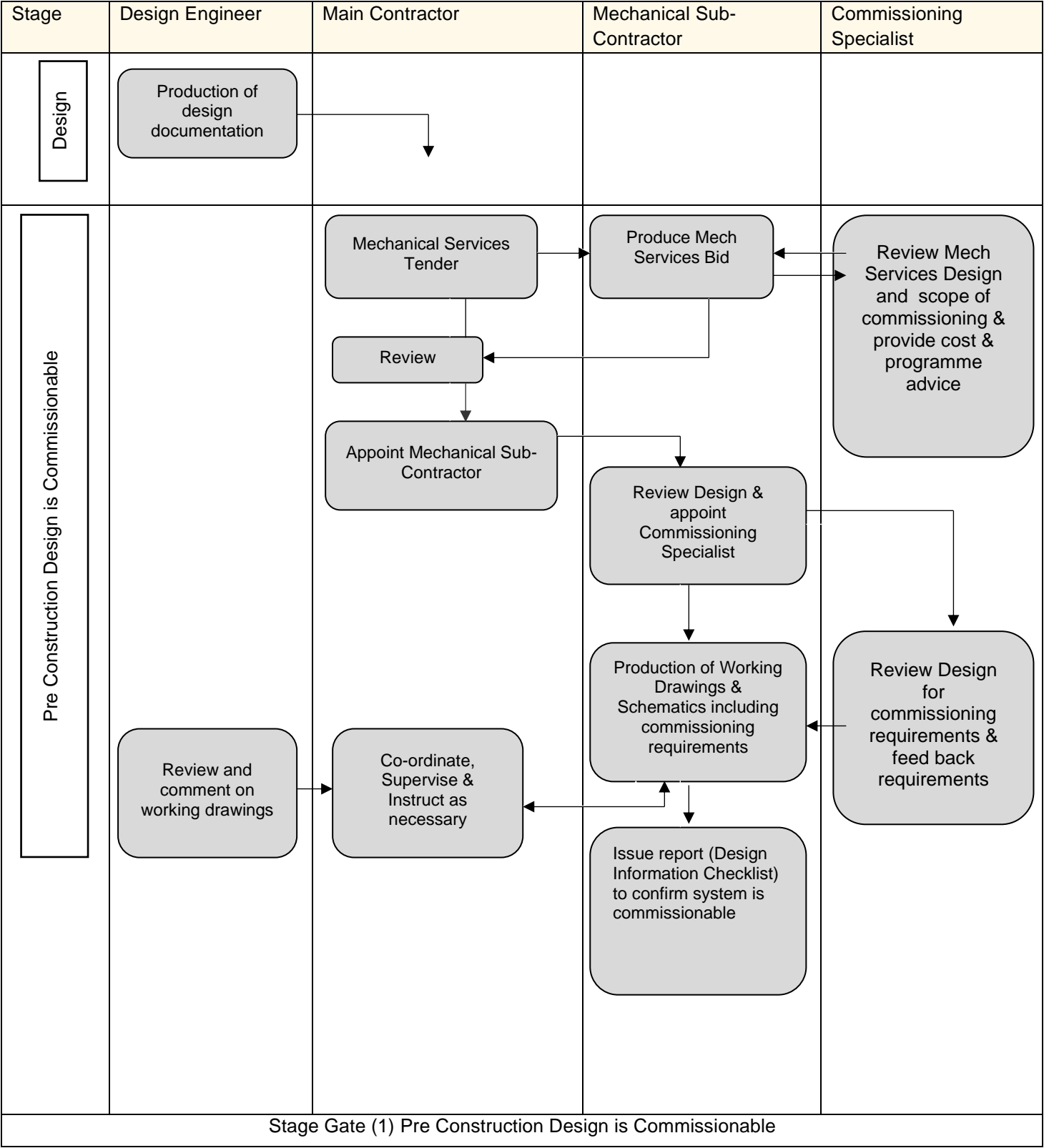
The Commissioning Specialist shall be responsible for providing the documentation listed below for inclusion in the operating and maintenance documentation: -

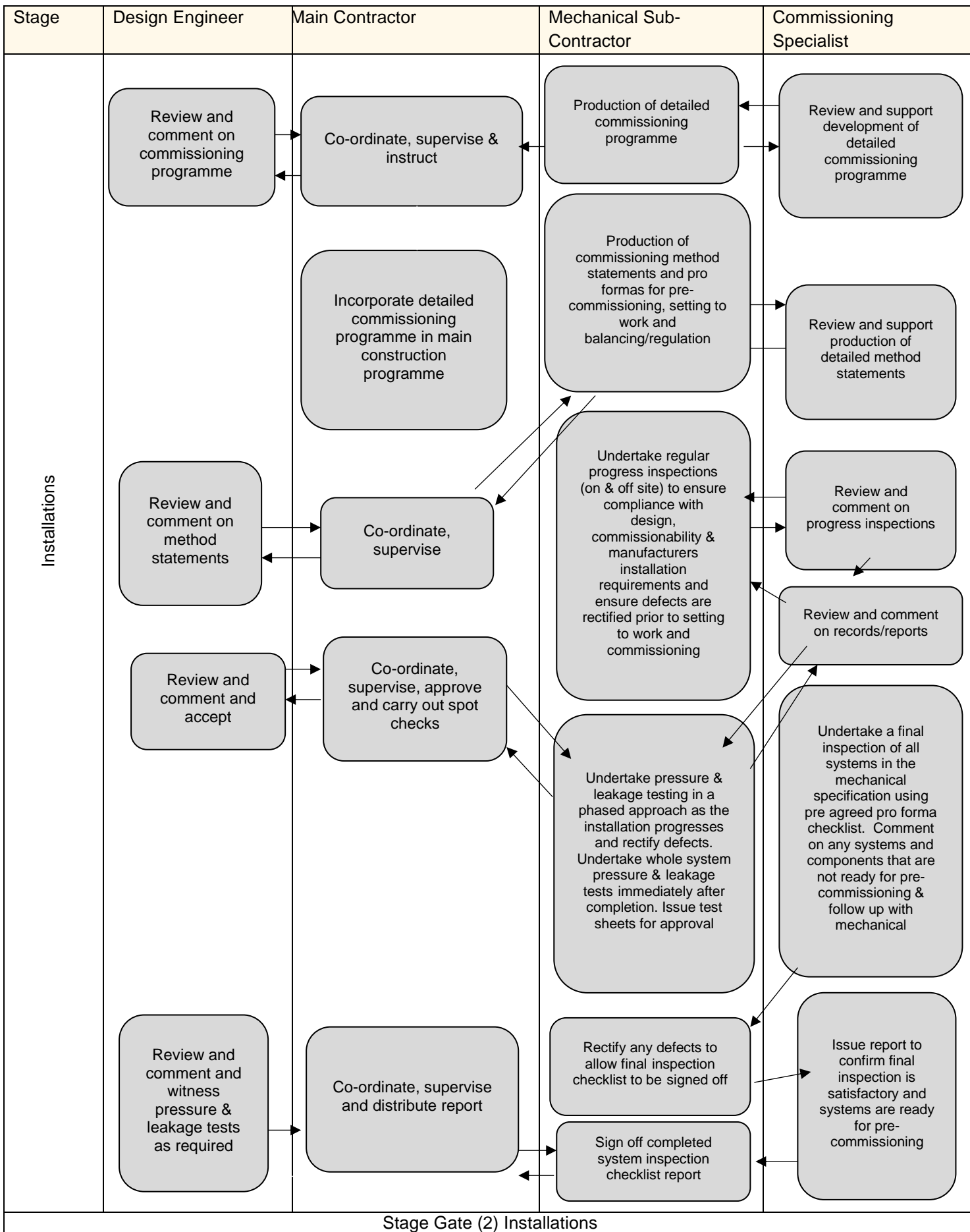
- 1) Fully signed masters and copies of all commissioning records and test sheets as detailed earlier in this Specification (Hard copy and PDF)
- 2) Details of any amendments to the installed plant and equipment (e.g. changes to belt and pulley sizes).
- 3) Details of any off site test sheets as detailed earlier in this Specification.
- 4) The Commissioning Specialist shall be responsible for programming the progress of compilation of record drawings and manuals and shall ensure these are completed in their entirety PRIOR to handover and Practical Completion.

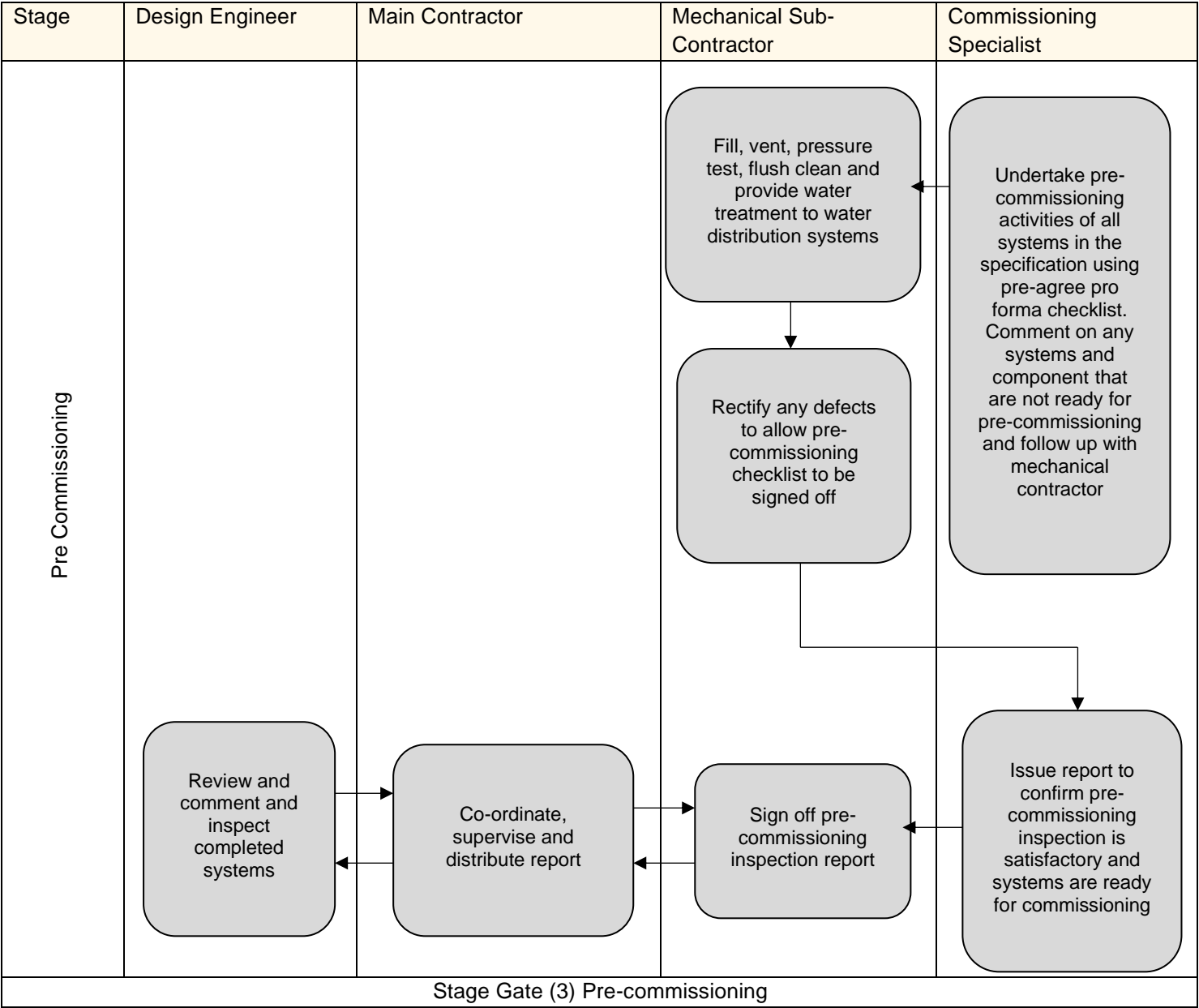
12.29 Liaison with Statutory Authorities

The Commissioning Specialist shall arrange all necessary liaison with the statutory authorities as appropriate. This shall include but not be limited to the Building Control Officer and the Fire Officer. The statutory authorities shall carry out all the required witnessing of the completed systems prior to their handover to the Client.

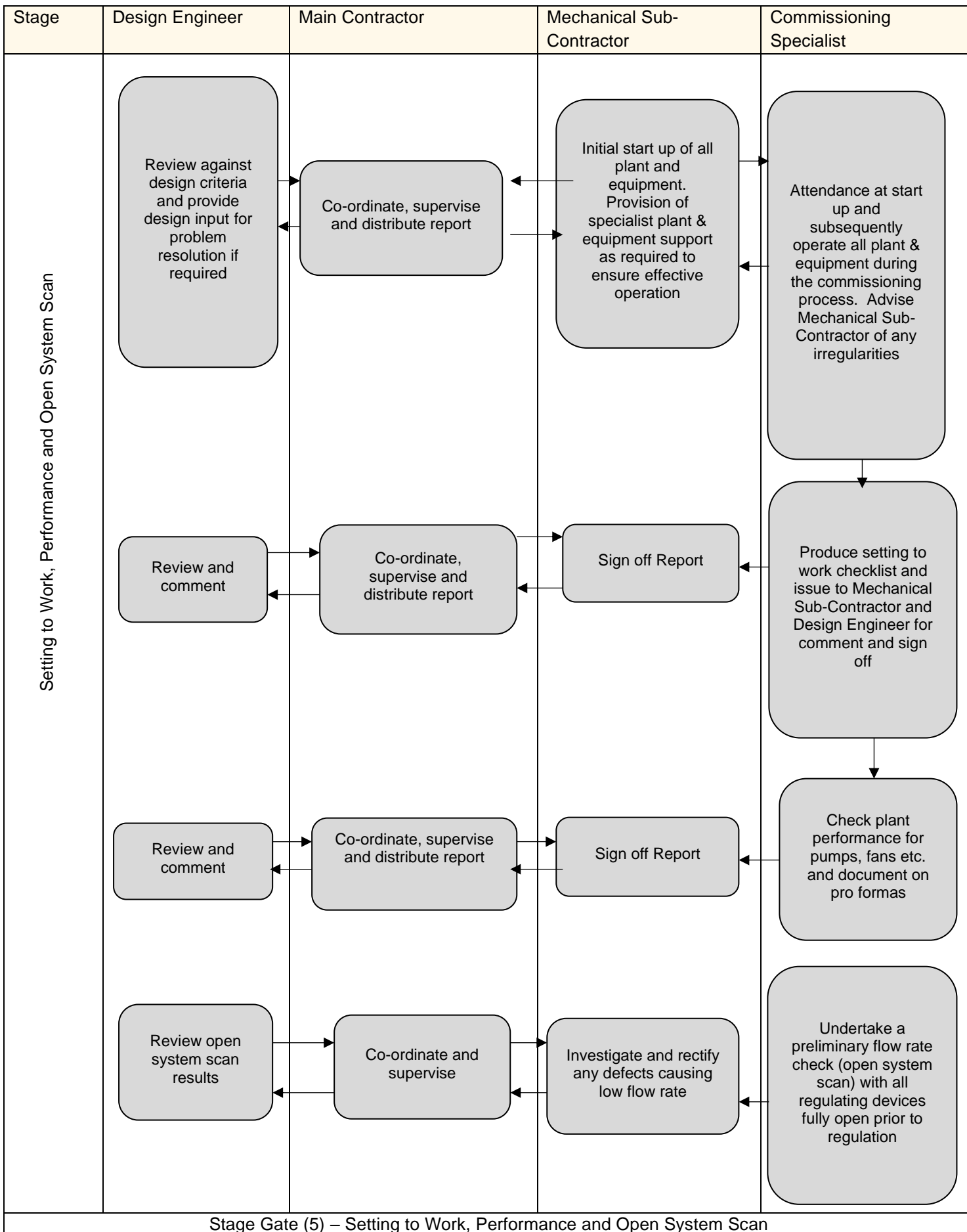
12.30 Typical Commissioning Flowchart



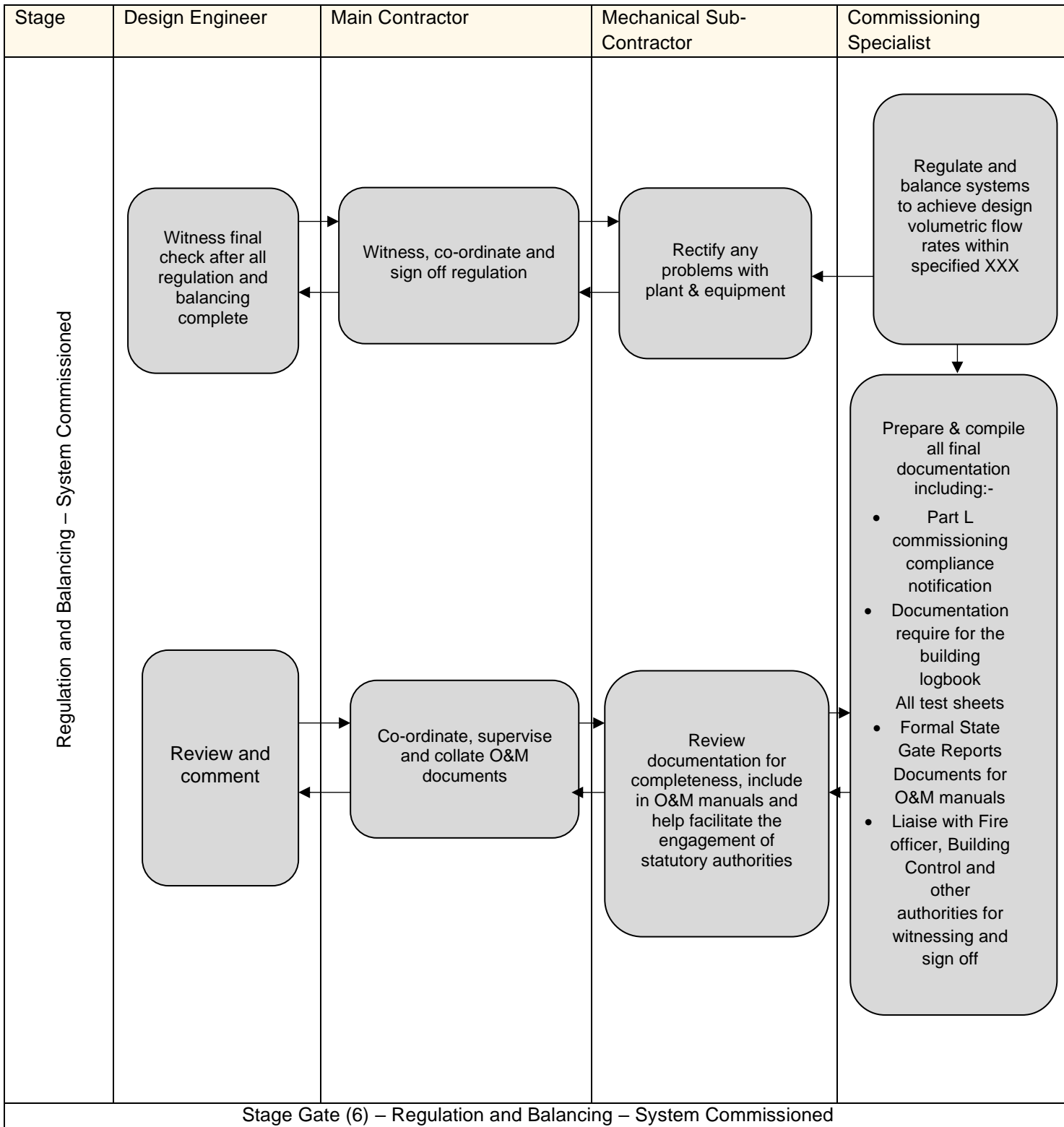


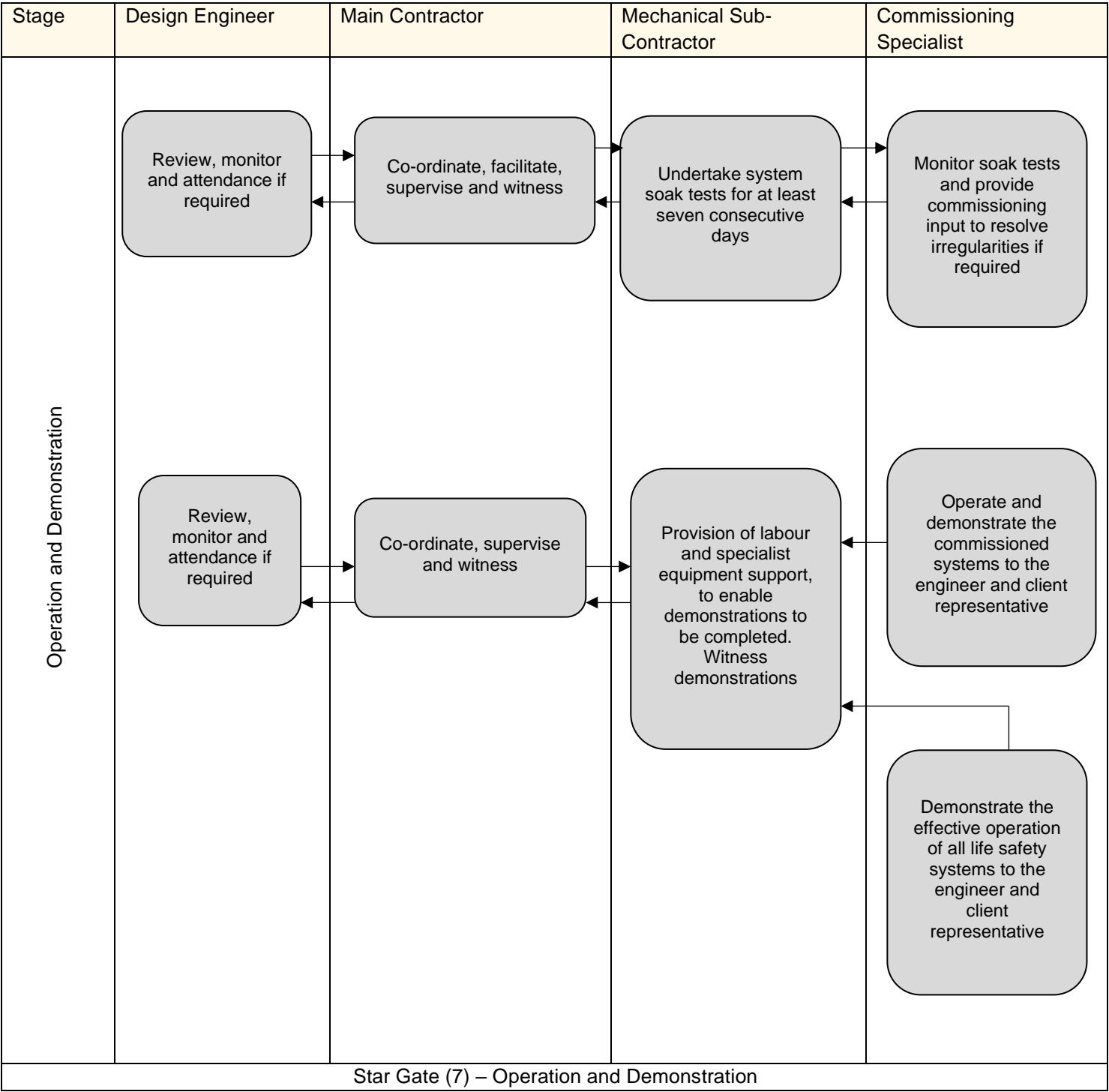


| Stage | Design Engineer | Main Contractor | Mechanical Sub-Contractor | Commissioning Specialist |
|--|--|---|--|--------------------------|
| Reports Prior to Setting to Work | <div>Production of report/checklist identifying all relevant steps have been completed prior to setting to work of plant and equipment. Report to include the foregoing steps in this flow chart and will include but not be limited to the following:</div> <ul style="list-style-type: none">• Essential design information• Manufacturer's essential data• Manufacturer's off-site tests• Pressure/ leakage tests<ul style="list-style-type: none">• Continuous installation inspections• Final installation inspections• System cleanliness inspections• Pre-commissioning inspections• Setting to work of fans, boilers, refrigeration plant, pressurisation units, Automatic controls, pumps, chillers, CHP, natural vent, air compressors, etc• BMS point to point checks• Life Safety Systems point to point check 100%• Possession of compliance documents and certificates | | | |
| | <div>Review, comment and witness report sign off</div> | <div>Co-ordinate, supervise and distribute report</div> | <div>Examine and sign off report</div> | |
| Stage Gate (4) – Final Co-ordination of all Commissioning Reports Prior to Setting to Work | | | | |



Stage Gate (5) – Setting to Work, Performance and Open System Scan





13 Spares

The Contractor shall supply in suitable containers sufficient lubricating motor oil and lubricating grease, together with all filling cans and grease guns suitable for all plant and equipment supplied under the Mechanical Contract to last over a period of twelve months from the date of handing over. In addition to the aforementioned items and those listed in the Particular Specification Section, the Contractor shall supply the following spares.

- 3 No. Air cock keys.
- 3 No. Keys for lockshield valves.
- 6 No. Keys for opening of access panels for air handling units.

14 Labelling and Identification

All items of apparatus, valves and cocks etc., except radiator and sill line heating element valves, shall have attached hereto non-ferrous labels suitably engraved with a number indicating the duty or operation of the item. The valves and stopcocks, unless otherwise directed, shall be fitted with coloured hand wheels and an engraved circular brass label in accordance with BS 1710.

The circular Traffolyte labels shall be attached to valves between the top of the hand wheel and the spindle nut. The circular Traffolyte labels shall be attached to stopcocks by means of a length of brass chain secured around the body of the stopcock.

Hand written or tape printed labels shall not be accepted.

All major items of equipment and apparatus shall have maker's labels securely attached, on which is to be inscribed the relevant details of duty, reference, date of supply. In addition, a non-ferrous label, such as a Traffolyte label, shall be secured to each item of plant. The label shall provide a brief identification of the item and can, if appropriate, double as the electrical isolation switch identification label. All labels shall be mechanically fixed using self-tapping screws or brass chains. Glues of self-adhesive labels shall not be permitted.

Every item of apparatus which requires lubrication or any other attention is to be labelled with the appropriate instruction or lubrication instructions.

Pipe service identification shall be by 300mm long coloured bands, superimposed on the primary colour and complying with the recommendations of BS 1710.

The pipe service identification bands shall be painted at not more than 10 metre centres in false ceiling and pipe ducts etc.

Glazed framed charts shall be hung in the plant rooms and shall provide the following information relevant to that plant room:

- a) Valve identification - showing service and valve size.
- b) System schematic diagram.
- c) Colours used for pipe/duct service identification.

15 Contractor's Drawings

Working drawings are to be prepared by the Contractor and submitted to the Contract Administrator, allowing at least 28 days for comments. Any work started on site inside these 28 days shall be at the Contractors risk, any alterations required to installed services following the comment process shall be undertaken at the Contractors cost.

Drawings to be supplied by the Contractor shall be as follows:

- a) Details of all purpose-made radiators, convectors, heaters, coils, unit heaters, brackets, supports and mountings to a scale of not less than 1/20.
- b) Details of all service layouts to a scale of not less than 1/50
- c) Details of all plant and tank rooms and boiler houses to a scale of not less than 1/20.
- d) All ranges of fabricated equipment and plant such as ducting etc. to a scale of not less than 1/50.
- e) Detailed electrical wiring diagrams of all equipment supplied by the Contractor, showing all interconnections (suitably numbered) between equipment to enable the necessary wiring to be carried out.
- f) Details of all associated builder's work to a scale of not less than 1:50.

One copy of all working drawings that include pipework and/or ductwork layouts shall be colour coded to identify each separate service system, i.e., LPHW heating, primary hot water service, secondary hot water service etc.

Co-ordination of services installations is to be the responsibility of all Contractors and be undertaken during the production of working drawings and not on site.

16 Electrical Services

All equipment to be installed and tested in accordance with the manufacturer's specific recommendation.

16.1 Electric Motors

All motors required to drive plant that form part of this contract shall be supplied and fixed by the Contractor. The motors shall be of the type and manufacture specified.

The motors shall be capable of developing the necessary brake horse power (hp) at the required running speed without causing undue noise or hum under all conditions of loading and to comply with BS 5000 as applicable. "Super Silent" type motors shall be supplied and fitted by the Contractor where specified.

All motors used for belt drives and elsewhere shall be supplied complete with a means for each motor used for belt drives.

Where capacitors are used with single-phase motors, these shall be watertight with enclosed terminals and are to be fixed to the motor.

If any external circuit wiring is to be taken to these capacitors, they must have a conduit entry.

The Contractor shall ensure that all motors supplied have been fully tested by the manufacturers before leaving their works.

The motors shall comply with the following:

Temperature rise, rating and overload.
Minimum insulation resistance.
High voltage test.

All as set out in BS 5000. In addition, tests shall be taken to determine power factor, efficiency and stalling load and also for silence and running. Further tests shall be carried out on site after erection at various loads.

16.2 Motor Starters

All motor starters and control gear shall comply with the appropriate British Standards Specification where applicable and in particular with the following, and be supplied by one manufacturer only:

| | |
|-------------|----------------------------|
| BS EN 60947 | Switch gear & control gear |
| BS EN 60051 | Ammeters |
| BS 148 | Insulating oil |

Motor starter or control gear operating coils shall be wound for 240 volts AC. DC operating coils shall be fitted where required. In this case a suitable rectifying unit shall be provided for the control circuit supply.

Motor Starters shall be suitable for operation of the type of motor to be controlled.

16.3 Contractors & Relays

All contactors and relays shall be of robust construction; laminations and windings are to be suitable for continuous duty and so arranged that when energised there is complete absence of noise, hum or any vibration. Where necessary, magnetic blow-outs with arc shields shall be provided for the main circuit contacts.

The contact fingers are to be designed to have a wiping action and shall be easily renewable.

Unless otherwise specified, all operating coils shall be wound for 240 volts operation either AC or DC as specified.

16.4 Push Button Units

Push button units are to be incorporated in starter panels as required. The buttons shall protrude through the case or consist of a separate unit securely fixed to the motor starter panel.

The push button shall be coloured differently to bear the inset words "START", "STOP", "SLOW", "FAST" as appropriate. All push buttons shall be the protected type.

16.5 Rotary Switches

Rotary switches shall be suitable for 240 volts AC and shall have the number of operating positions and switching sequences suitable for the type of circuit controls required.

Each rotary switch shall have the necessary number of contacts of ample current carrying capacity which shall be mounted on a common frame and be complete with copper shorting links between the terminals required.

Terminals for the connection of control circuit cables with two brass nuts and washers and one Ross Courtenay washer of size not less than 2 BA. Contacts shall be silver faced.

Rotary switch control handles shall be of the lever type and the switching action shall be of the quick make and break type.

The whole unit shall be enclosed in a sheet metal or cast case or flush mounted on a common unit in the case of multi-motor starter panels.

Rotary switch cases shall be suitable for the entry of either conduits or MICC cables as required.

The front plate of each rotary switch shall be engraved to denote the functions of the various position settings of the switch.

16.6 Indicator Lights

Indicator lights shall be suitable for operation on 6 volt AC supply and shall be complete with integral double wound 240/6 volt transformer to form a complete unit. The necessary panel mounting fixings and lamp holder supports shall be provided as part of the indicator lamp assembly. This assembly shall also be complete with a suitable bezel and heat resisting translucent plastic lens of appropriate colour.

The indicator units shall be designed so that the lamp may be replaced from the front of the panel by unscrewing the lens. Each unit shall be complete with a 6 volt 250 mA lamp.

The whole assembly shall be so arranged that, when mounted in the starter panels, no cross lighting shall take place between the indicators by means of light from one indicator illuminating another indicator.

Lens colours shall be:

| | |
|---------------|---|
| Red | - Machine Running |
| Amber | - Apparatus Failure, to be used only if this failure is dangerous |
| Blue or White | - General Indication |

Transformers, coils, relays and other items of equipment that form part of the electrical services associated with the mechanical installation shall be insulated with materials which retain their insulation properties whilst subject to high ambient temperatures.

On each panel include a button and engraved plate entitled lamp test button. When pressed all panel lamps shall activate.

Panel shall be form 2 standards unless otherwise stated elsewhere.

16.7 Regulations

All electrical materials and the whole of the electrical installation associated with the mechanical services contract shall be in strict accordance with current edition of the Wiring regulations, with the latest amendments as issued by the Institution of Electrical Engineers, the associated Electrical Specification to this Mechanical Specification and also, Local Authorities, the Electricity Supply Authority and all other parties concerned.

16.8 Float Switches

One Level Float Switches

Switches are to have the necessary number of single pole or double pole contacts, to be quick make and break, positive action, phosphor bronze, of ample current carrying capacity, heavily faced with rolled silver. All contacts to be easily renewable and connections to be by means of 2 BA brass terminal posts with washers and locknuts. The whole to be enclosed in a watertight phosphor bronze or aluminium bronze case with removable cover.

Two Level Float Switches

To be generally as described for one level float switches except that they are to be suitable for operation and complete with either:

- a) Steel wire rope, counterweight pulley and copper float, or
- b) Steel rod and copper float

All screws used for fixing cover etc. are to be non-ferrous type.

16.9 Terminal Blocks for Control Panels

Terminal blocks are to have a high quality insulating material base on which are mounted sufficient terminals to allow for one terminal per cable. If two or more cables are to be connected for a common circuit, this is to be carried out by means of the necessary shorting links between terminals and not by bunching two or more cables on one terminal.

The connection between the internal and external wiring is to be by means of two terminals connected together by a copper link in such a manner that any one cable may be disconnected without disturbing any other cable connection. All terminals are to be OBA each with two full size nuts, two washers and one Ross Courtenay washer.

Terminal stud nuts and washers are to be manufactured from brass or high grade phosphor bronze.

Pairs of terminals (which comprise one connection between internal and external wiring) are to be separated from each other by insulated separators and are to be labelled with the appropriate designation by means of Traffolyte labels.

The whole terminal assembly is to be shrouded by an insulated cover and mounted on a substantial mild steel frame with provisions for terminating cables.

17 Pollution & Interference

No toxic materials are to be utilised in the installation processes, testing and commissioning procedures or the permanent systems being incorporated into the works. The following list of materials are particularly prohibited.
Calcium Chloride

Blue, Brown or White Asbestos

High Aluminium Cement

Wood-wool slabs as permanent shuttering

All plant and equipment utilised, both during the period of the installation works and also all equipment installed as part of the permanent installation, shall be attenuated to within recognised environmentally acceptable sound levels. All works shall conform to the Control of Pollution Act 1964 with current amendments and to the standard specified by BS 5228: 1975.

18 Domestic Water Services

18.1 Water Services – Generally

The entire domestic water services installations shall, unless otherwise stated in the Particular Specification, comply with the following:

- a) Building Regulation Approved Document G.
- b) British Standard Specification BS 6700 : 2006 or the most recent revision.
- c) All National and Local Water Bye-Laws as set out in the Local Water Authority's Byelaw Regulations.
- d) The latest issue of the Guide to Current Practice by the Chartered Institute of Building Services Engineers.
- e) The current edition of the Institute of Plumbing "Plumbing Services Design Guide".
- f) The current edition of the IEE Regulations.
- g) Manufacturer's stipulations and recommendations for installation and testing.

18.2 Incoming Water Mains, Hot and Cold Water Services

Pipework

All internal pipework shall be installed in copper tubing to BSEN 1057-1, with compression non-dezincifiable capillary fittings to BSEN 1254.

Generally, pipework shall be supported on brass screw on brackets, as Yorkshire Fig No 108 or equal.

Suspended pipework shall be supported with brass brackets, as Yorkshire Fig No 107 or equivalent, with mild steel drop rods and secured to the structure with self-drill anchors or alternative fixing to suit the particular structure circumstances.

WRAC approved pressure reducing valves shall be provided where required to meet pressure requirements of equipment and outlets. Ensure equal pressures are provided at thermostatic blending valves and showers.

Valves and Fittings

All valves and fittings shall be as detailed elsewhere within the Specification.

18.3 Cold Water Storage Tanks

Unless detailed otherwise within the Particular section of the Specification, all cold water storage tanks shall be glass reinforced plastic sectional tanks as manufactured by Dewey Waters Limited or equal.

All cold water storage tanks shall be constructed and installed to fully comply with Byelaw 30 of the Model Byelaws and in accordance with BS 6700: 2006.

The tanks shall be complete with all the necessary bracing devices, brackets and stays complete with lids and installed on site in strict accordance with the manufacturer's instructions, recommendations and specifications.

Outlet connections to tanks shall be made in accordance with the manufacturer's instructions. Position of all connections shall conform with the manufacturer's recommendations and to the requirements of BS 6700, to ensure an even throughput of water and to avoid localised stagnation points.

18.4 Hot Water Storage Cylinders/Calorifiers

Hot water storage cylinders shall, unless stated otherwise in the Particular Specification, be indirect one piece vertical type made from copper sheet to BSEN 1653 with seams and joints homogeneously welded or brazed with zinc free alloy in accordance with the requirements of BS 853 or BS 1566-1. All connections shall be screwed connections to BSP and shall conform to BSEN ISO 228 tested to 1Y2 times their intended working pressure.

Cylinders and calorifiers shall be suitable for the working pressure of the system. All hot water cylinders shall be fitted with the following accessories:

- a) Pressure/temperature safety valve with copper drip pipe to low level, installed close to the top of the cylinder. The safety valves shall be set to operate at twice the working pressure of the system and below the maximum capacity of all plant items.
- b) A 100mm diameter dial type thermometer installed close to the top of the cylinder.
- c) All cold feed, primary and secondary inlets and outlets required by the system.
- d) A drain cock.
- e) A 3.0kW electric back-up immersion heater, complete with integral thermostat, unless stated otherwise in the Particular Specification.
- f) A sensor pocket installed two thirds toward the top of the cylinder complete with a thread suitably sized to install the required make of operating sensor.
- g) A fully accessible clean-out door/access manway on cylinders with a storage capacity of 1000 litres and over.
- h) Full insulation in accordance with the relevant clauses of the Specification.

Refer to Mechanical Services Performance Specification for details of any point of use water heaters.

18.5 Overflow & Warning Pipes

Overflow and warning pipes shall discharge externally where possible in conspicuous positions. The exact method and termination points are to be confirmed and agreed with the Local Water Authority. Overflows and warning pipes shall be installed in copper tube to BSEN 12449 : and shall include, when required by the Water Byelaws, an insect screen.

All overflows shall be water tested for soundness under working conditions and shall be arranged to meet Local Water Authority requirements.

18.6 Sterilisation & Testing

Sterilisation of Water Mains, Service Pipes, Distribution Pipes & Storage Tanks

All new pipework and storage tanks shall be sterilised in accordance with BS 6700, before the system is brought into use for domestic purposes. Before sterilisation, pipework and storage cisterns/tanks shall be flushed out to remove dirty water, debris etc. No water shall be used for domestic purposes during this flushing operation, nor until sterilisation has been completed. Mains extensions shall be sterilised first followed by communications and supply pipes, storage cisterns/tanks and distributing pipes in that order.

Main extensions, communications and supply local pipes may at the request of the Contractor be sterilised by the Local Water Authority. Alternatively the Contractor may make arrangements with an approved specialist firm to sterilise the supply pipes by means of portable chlorinating equipment. The Contractor shall pay all charges and for the water used for sterilisation and flushing out.

Storage cisterns/tanks and distributing pipes shall first be filled with water and be thoroughly flushed out. With all draw-off taps closed, the cistern/tank shall be refilled with water and sufficient sterilising chemical shall be added during filling to ensure that when full, the cistern/tank contains water having a concentration of 50mg/litre of chlorine in solution.

The sterilising chemicals shall be prepared in accordance with the manufacturer's instructions. The supply into the cistern/tank shall then be stopped and all the draw-off taps on the distributing pipes shall be opened progressively, working away from the cistern/tank. Each tap shall be closed when the water begins to smell of chlorine. The system being sterilised shall then be left to stand for a period of one hour. After the hour, water shall be drawn off from the system, flushed through with clean mains water and be tested for residual chlorine. If none is found, the test shall be repeated. Finally, the cistern/tank and pipes shall be thoroughly flushed out before any water is used for domestic purposes.

Testing

The Contractor shall provide all assistance and appliances for testing during the progress of the contract and for the final tests. He shall also provide, fix and adequately support all necessary blanked ends and plugs for testing purposes.

The Contractor shall ensure that all pipelines are completely clear of any obstruction, debris and superfluous matter before any tests are applied to such sections, and upon completion of the contract.

The Contractor shall give notice of testing to the Contract Administrator.

All services shall be inspected and tested as specified and to the satisfaction of the Contract Administrator.

Water mains shall be slowly filled with water so as to exclude all air and pressure shall be applied until a test pressure of 90m head or 1.5 times the maximum working pressure, whichever is the greater, is indicated on the gauge. Without further pumping this pressure shall be maintained without measurable loss for at least 30 minutes.

Distributing pipes (cold water down service, cold feeds etc.) and storage cisterns shall be slowly filled with water to allow all air to escape. When all draw-off taps are closed, the system shall be absolutely watertight.

Distributing pipes shall be tested to maximum working pressure plus 50% or to 14ni head, whichever is the greater. The pressure, without measurable loss, shall be maintained for 30 minutes.

18.7 Workmanship Generally

Generally, all sanitary appliances shall be supplied from the storage cisterns or tanks unless specifically noted to be provided with drinking water.

During construction work, all open ended pipework shall be suitably sealed to prevent the entry of foreign matter into any part of the system.

Jointing material must not project into the bore or pipes, fittings or appliances.

All horizontal runs of pipes shall have a slight rise or fall in order that the system may be drained. Pipe runs shall be set out and fixed to avoid 'traps' and air locks.

All pipes and fittings shall be fixed in accordance with the pipe manufacturers recommendations.

Maximum spacing of supports for copper pipework shall be as 'Pipe Supports and Hangers etc.

Supports shall also be provided adjacent to all valves, cocks and other special components to prevent undue strain on the adjoining pipework and so that components can be removed leaving the adjoining pipework adequately supported at the ends.

All mains subject to high variations in pressure shall have additional supports at all changes in direction (i.e. bends, tees, etc.) to resist displacing forces.

Ensure that no impure water is allowed to enter any pipe runs.

All low points in pipework are to be fitted with draincocks in positions where necessary to ensure that pipework can be drained.

Stopcock controls shall be installed on incoming mains immediately as they enter the building with draincock immediately above stopcock to enable pipework to be drained.

Stopcock controls shall be installed adjacent to ball valves. Stop valves (gate valves) to be installed on branches to individual or ranges of sanitary fittings.

All drinking water points shall be clearly identified and labelled using an engraved traffolyte label screw fixed in a position to be agreed with the Contract Administrator.

Gate valve controls shall be installed on cold water down services as near as practicable to cold water storage tanks.

Connections to sanitary fittings and other equipment shall be made with swivel couplings.

Cold water down service pipework shall connect to cold water storage tanks with suitable tank connectors or as previously described under 'Cold Water Storage Tanks'.

Approving Authorities

All materials in the Works shall be of a type and standard acceptable to the Local Authority and shall be of an equal or better quality, type, finish and/or workmanship than that specified in the appropriate current British Standards Specification where such exists.

The British Standard or Code of Practice shall be regarded as the minimum acceptable standard and the Contractor shall ensure that all materials and workmanship meet with the approval of the Local Authority.

19 Above Ground Soil & Waste Installations

19.1 Scope of Works

The above ground soil and waste installations for the Contract shall comprise the supply, installation, testing and commissioning of the complete installations as detailed in the particular section of the specification, to the standards and regulations specified.

The Contractor shall be responsible for submitting all relevant information to the statutory authorities and obtaining their approval on the services installed as a whole.

The clauses relating to this Specification have been primarily prepared to describe in basic terms the proposed installations, their working principles and the installation methods. They are intended to be read in conjunction with the remainder of this Specification.

19.2 Regulations

The Contractor shall ensure that the installation of the above ground soil and waste installation shall comply with all statutory and Local Authority regulations, with particular reference to:-

- a) All related British Standard Specifications and British Standard Codes of Practice.
- b) Requirements of the relevant Local Water Supply Company.
- c) The Chartered Institute of Building Services Guide and Institute of Plumbing Data Book.
- d) The Building Regulations approved documents.
- e) Building Research Station Digest recommendations.
- f) Recommendations of the Health and Safety at Work Executive.
- g) Manufacturer's stipulations and recommendations for installation and testing.
- h) Local byelaws and regulations.
- i) The Employer's insurers.
- j) All other authorities having jurisdiction.

19.3 Working Drawings

Copies of working drawings shall be submitted by the Contractor to the Clients Representative for comments and again to the Client's Representative for sanction prior to ordering of materials and commencement work.

Drawings shall be approved for compliance with the design intent only, such approval shall in no way diminish the responsibilities of the Contractor.

Working drawings shall comprise but not be limited to the following:-

| | |
|---|------|
| Full set of co-ordinated floor plans | 1:50 |
| Details of sanitary plumbing and water services layout and toilet areas | 1:20 |
| Coordinated service duct layouts | 1:10 |
| Details of access panels required for maintenance purposes | 1:50 |

Diagrammatic layouts of sanitary plumbing and water services installations.

The Contractor shall be responsible for the preparation of builder's work drawings and details (1:50 scale), including all channels, cases, pockets, trenches, holes and the like which require to be formed in the building structure. Such drawings and details shall be prepared in consultation with the Clients Representative.

19.4 Sanitary Plumbing Installation

- a) Workmanship Generally

The work shall conform to the Specification in all respects and be executed by fully qualified, competent tradesmen and certified welders, in accordance with the Specification to the satisfaction of, and as directed by, the Clients Representative and the relevant Local Authorities.

- b) Relevant Codes of Practice

Attention is drawn to the following Codes of Practice where they are applicable and do not conflict with this Specification:

BSEN 12056-2 Code of Practice for Sanitary Pipework

- c) Sanitary Fittings, Traps

1. Lavatory Basins 35mm waste pipe. 35 x 75mm seal trap (two piece tubular)
2. Sinks 42mm waste pipe. 42 x 75mm seal trap (two piece tubular)
3. Urinals 42mm waste pipe. 42 x 75mm seal trap (two piece tubular)*

4. Water Closets 100mm soil pipe generally, trap incorporated within fitting
5. Sanitary Disposal Units 50mm waste pipe. Trap incorporated within fitting.

Soil Ventilation Pipework

All internal soil/vent pipework shall be installed in uPVC pipework and fittings to BS 4514: 2001, as manufactured by Polypipe Terrain Limited plastic plumbing and drainage systems, with solvent welded ring seal or appropriate expansion jointings.

The manufacturer's fixing instructions, support and fixing recommendations must be strictly adhered to. All soil and vent pipes shall terminate with a uPVC balloon guard.

Jointing and Fixings (uPVC)

The installation, method of jointing and fixing shall comply in all respects to the manufacturer's fixing instructions. uPVC is to be jointed by means of solvent welding using the manufacturer's approved cleaning fluid and solvent cement.

Pipework is to be supported by means of galvanised MS holderbats, with two suitable fixed positions either acting as a pipe support but allowing thermal movement, or as a clamp fit on a fitting creating a fixed point. For optimum fit to pipe supports, special purpose made PVC packing pieces should be used. The maximum intervals between pipe supports shall be as follows:

| Pipe Dia. | Maximum Distance for Horizontal Runs in Metres | Maximum Distance for Vertical Runs in Metres |
|------------------|---|---|
| 32mm | 0.500 | 1.200 |
| 40mm | 0.500 | 1.200 |
| 50mm | 0.900 | 1.200 |
| 82mm | 0.900 | 2.000 |
| 110mm | 1.000 | 2.000 |
| 160mm | 1.000 | 2.000 |

Pipes passing through fire stopped walls and floors shall include intumescent fire sleeves to fixed securely to the structure.

The system shall be installed to accommodate thermal movement between fixed points by installing expansion joints of the seal ring type.

Expansion joints shall be fitted if the fixed points are greater than 1000mm apart, or on long straight runs without fixed points at maximum 3600mm apart. These positions are determined by the holderbat fixing positions made to the sockets of fittings or determined by pipes passing through the building structure.

19.5 Installation of Sanitary Plumbing Fittings

- a) Where any discrepancy between the drawings and specification is noted the Consultant Building Services Engineer is to be informed and his further instructions obtained before the work proceeds.
- b) Make connection to the drain points as described and run from these points to the roof and terminate with balloon guards on all vent pipes. The pipes shall be complete with all necessary bends and fittings.
- c) Access shall be provided at the foot of all stacks and at other various points throughout the system to enable adequate maintenance to be carried out.
- d) Most, but not all, access is indicated on the drawings.

- e) It shall be the Plumbing Contractor's responsibility to ensure that all necessary access is provided and that access doors are correctly located in relation to duct access panels and duct frames, in order that future maintenance may be adequately carried out.
- f) Pipe access doors are to be on top of horizontal pipes unless this would make maintenance difficult, in which case side access is to be used. On no account should access doors be fitted on the underside of drain runs.
- g) Main pipes shall be fixed at constant falls.
- h) The pipes shall be free from throating, flattening, or rippling, and the bore and thickness shall be maintained.
- i) Vent pipes shall be carried up full bore 450mm, or as indicated above roof level, and in any case not less than 900mm above the head of any window opening or ventilated rooflight or within a horizontal distance of 3m.
- j) Branch anti-siphon pipes shall enter the main vent pipe above the spill level of the sanitary fittings being served.

An air test is to be applied to all sanitary plumbing and shall be carried out in strict accordance with Section 12 of BSEN 12056-2. As a minimum the sanitary plumbing system shall maintain a pressure of 40mm water gauge for a period of not less than 5 minutes.

Such other tests are to be carried out as may be directed by the Clients Representative or Authorities to assert correct hydraulic performance, functioning and construction of the system.

Electrical continuity test for a 'Timesaver' coupling shall be that, when assembled on non-conducting supports and without restraining supports, a voltage (V) not exceeding 50V AC 50Hz shall be applied to the pipes across the joint assembly so that a non-fluctuating current of 25 amps flows through the joint assembly for 30 seconds. The resistance (R) of the joint assembly shall be calculated from the voltage and current using the formula.

$R = \frac{V}{I}$ 25 and shall not exceed 0.3 ohms.

20 Operating & Maintenance Instructions

The Contractor shall supply and hand over to the Contract Administrator comprehensive Operating and Maintenance Instruction Manuals in accordance with BSRIA Guide BG 1/2007 as detailed below:-

The Contractor shall include for instructing the Employer's staff in the operation and maintenance of all equipment included in the Mechanical Services Contract. The Contractor shall supply the first draft of the manual at least 2 weeks prior to anticipated contract completion date for comment.

A special section shall be included in the operating instructions for dealing with fault finding emergency procedure in case of plant malfunction or equipment failure and shall indicate to the maintenance staff procedure to be adopted in the event of the possible failures which could occur, and the quickest method of rectifying them, be they temporary measures or entail contacting a manufacturer's emergency service.

Three hard copies of the finalised manual are to be provided, plus one in a computer based format, i.e. CD's. One of these copies shall be passed to the Employer's Maintenance staff, who after receiving the manual may be instructed by the Contractor in the operation and maintenance of the plant.

The manual shall conform to the following minimum standards:

The manual shall be a two ring PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins. The size of the manual shall not be larger than international size A3.

The cover shall be printed with the following information:

Operating and Maintenance Instruction Manual for the project name. Services covered.

Where more than one volume is necessary the volume number is to be printed.

Each section of the manual shall be divided by a stiff divider of the same size as the holder. The divider shall be labelled as the section of the manual which is following.

The arrangement of the manual shall be as follows:

SECTION ONE

Contents,

SECTION TWO

Description of the design of the system.

SECTION THREE

Description to the operational routines.

The description must include step by step instructions on starting and stopping each plant or system.

SECTION FOUR

Equipment schedule with model references and part numbers.

SECTION FIVE

Planned maintenance instructions.

Instructions must include written step by step instructions on the maintenance of all items of plant. Data shall also be provided for ordering replacements. Full sets of manufacturer's maintenance instructions including wiring diagrams and typical fault finding routines.

SECTION SIX

A set of test and commissioning certificates

SECTION SEVEN

Emergency measures, including telephone number of Contractor's emergency staff.
Names, addresses and telephone numbers of all manufacturers.

SECTION EIGHT

A set of record drawings

If necessary due to the number of drawings which have to be included in the manual, each drawing shall be photographically reduced in size to suit the manual.

The manual shall be handed to the Contract Administrator at the practical completion.

21 Record Drawings

The Contractor shall supply a comprehensive set of Record Drawings of the Works.

Twenty-one days before the anticipated contract completion date, the Contractor shall supply draft copies of all Record Drawings.

The completed and approved drawings shall be signed by the Contractor as Record Drawings and shall be handed over at practical completion of the Contract.

Full details shall be shown of the installation including positions of valves, draincocks, air vents and control equipment as actually installed.

Valve charts for all boiler houses and plant rooms shall be submitted for approval in time for these to be corrected, framed and displayed at the hand over inspection.

All drawings shall be issued at practical completion the complete approved package of record drawings in the following numbers and format:

- CAD format on CD disk. Each CD shall be labelled and the CD jewel cases shall be labelled identifying project title, issue date and index of contents.
- Number of sets of complete record drawings (no) 2
- 'White' prints.
- Number of sets of complete record drawings (no) 2
- Provide reduced scale copies for inclusion in the operating and maintenance manuals as stated elsewhere.

Each drawing prepared by the Contractor shall have the following information on the drawing:

- Name of Contract and where appropriate, the phase number, zone or floor number.
- Description of drawing.
- Drawing number.
- Scale.
- Name and address of Contractor.
- Name and address of Engineer.