
Section 3 Particular Specification

3.0 Particular Specification

3.1 General

The installations are generally as outlined on the drawings and as specified herein. It shall be the responsibility of the mechanical services contractor to co-ordinate their services with those of other trades to avoid clashes. Any abortive work which occurs as a result of a clash due to lack of co-ordination shall be resolved without cost to the Client or their representatives.

3.2 Element 50 – Site Services (Mechanical-Strip Out)

The purpose of the strip-out works is to safely remove existing mechanical services within the science rooms to facilitate refurbishment and installation of upgraded systems and new architectural layout. This includes decommissioning and removal of all redundant equipment.

The mechanical strip-out shall include, but is not limited to:

- Removal of existing drainage and water services serving existing lab benches and sinks
- Removal of redundant plumbing pipework, water heaters. (Ensure no dead legs remain)
- Removal of redundant heating pipework, radiators, and associated valves
- Isolation, disconnection and removal of laboratory gas services
- Identification and protection of services to remain
- Isolation disconnection and removal of existing ventilation systems (ductwork, extract fans)

All works shall be coordinated with electrical and architectural elements to avoid conflicts. The mechanical contractor shall engage fully with the electrical engineer to ensure safe isolation and disconnection of mechanical services before removal.

3.3 Element 52 – Drainage and Refuse Disposal

The existing wastes shall be stripped back, with all redundant sections removed.

The mechanical contractor shall allow for supply and fitting all above ground waste connections as required within the science classrooms and ancillary rooms.

A system of plastic discharge pipes will convey foul discharge from the various areas of the ground floor level to connect to new builder's pop-up drainage provided by the main contractor.

Each item of sanitaryware shall be supplied under the main contract complete with all associated taps, traps and fixing brackets. The mechanical contractor shall fit all items of sanitaryware as supplied by the main contractor.

Where soil and waste pipework passes through any fire compartment wall an intumescent fire damper shall be fitted.

The contractor shall include for the supply and installation of acid resistant pipework to the dilution pots located in each pedestal in the Science Rooms.

All underground drainage is out with the scope of this package and will be detailed and provided by the main contractor.

The mechanical contractor must be cognisant of adjacent rooms (not within this scope of works) and assess the soils and waste systems in these areas, as strip-out works may affect existing connections within these spaces.

3.4 Element 53 – Domestic Water Services (DWS)

The existing DWS shall be stripped back to the prep room area where the water services emanate, with all redundant sections removed. The pipework shall be properly valved and capped at the primary routes, ensuring that no dead legs remain.

The schools existing water services distribution in the building consists of mains and cold water pipework routing throughout the building. The hot water for the science classroom shall be generated from point of use electric water heaters to be installed under-sink. Generally, 1No. under sink water heater shall supply 2No. sinks unless distance between sinks limits this approach. As a consequence the existing mains water supply within the science classroom should be extended to serve both the mains water requirements and the under sink water heater.

All mains and hot water pipework will be adequately insulated to prevent against freezing, condensation and heat loss, in line with current best practice and building regulations.

The contractor is responsible for modifying the existing pipework system as needed to suit the new and updated layout. This includes making any changes, extending pipes, or rearranging them so everything works properly with the revised design layout. For ease of future maintenance, connections out to appliances should be served from DWS manifolds with continuous PEX pipe complete with associated isolating and balancing valves .

Cold Water Storage Tank (CWST)

No works is proposed to the existing CWST.

Hot Water Secondary Pump (N/A)

Pipework

All domestic water services shall be a gravity fed system (preferably).

The cold & hot water piping shall be polyethylene patented piping appropriate for use and distributed in the floor void.

Mains water piping feeding drinking taps shall be non-metallic pipes and fittings, e.g. polyethylene piping appropriate for use and distributed in the floor void.

Copper pipework may be used and where so, all domestic plumbing pipework shall be in accordance with the requirements of BS EN1976 & BS EN 1978 "Phosphorous De-Oxidised Non Arsenical Copper" or to the requirements of BS EN1976 & BS EN 1978 "Phosphorous De-Oxidised Arsenical Copper" and as detailed within the general specification section of this document.

The Contractor shall use only Kitemarked tube and potable range fittings. Solders containing lead must not be used in any instance.

Where copper can be used for Cold & Hot services, mains water pipework shall only be non-metallic.

Main branch stop valves shall be installed as shown on the drawings and in safely accessible locations. Ballofix valves shall be fitted to pipework at all sanitary appliances. Hot water taps shall be positioned on the left-hand side of all sanitary ware.

Pipework shall be installed with correct falls to ensure adequate venting and draining. No pipe joints or change in direction shall be permitted within the thickness of walls or floors, etc.

All pipework shall be free from burrs, corrosion, deleterious film, scaling, pitting and excess damage. Bores shall be clean and unobstructed. Pipework shall be thoroughly cleaned before installation.

Pipework shall be run neatly and parallel to the building structure and other pipework except for the required allowance for venting, draining, etc. All vertical pipework shall be installed plumb and square. Pipework which is to be subsequently insulated shall be spaced to allow an individual finish to each.

Purpose-made sets or springs may be used on mild steel or copper pipework, cold bent on site using an approved bending machine up to 42 mm and hot formed on 50 mm and above. Pipes shall remain circular after setting.

Eccentric reducers and enlargers shall be used on horizontal pipework runs to allow for draining and venting. Concentric reduces with 'easy' transformer shall be used on vertical pipes.

The Contractor shall ensure that all jointing materials and techniques are approved by the Supplier of the pipe systems for the particular application. For domestic hot and cold-water services all joint sealants shall be approved by the WRAS.

All metallic pipework systems shall be constructed and installed to provide electrical continuity throughout to comply with the requirements of the BS 7671. Electrical continuity shall be demonstrated on each completed system. Continuity shall be demonstrated without reliance on the content of the system. Where items incorporated into the pipework systems including fittings, joints and components break the electrical continuity, bonding conductors shall be supplied and installed to bridge the items. Electrical continuity clips shall be as the system manufacturers proprietary item. Where these are not available bonding conductors shall be 6 mm² minimum green/yellow PVC stranded copper cable or 10 mm x 1.5 mm tinned copper braid. Ends of bonding conductors shall incorporate crimped tinned copper lugs suitable for bolt fixing. The bonding conductor lugs shall be bolted with spring serrated washers to an adjacent flange bolt and extended clear of any thermal insulation or other finish. To ensure negligible impedance all contact surfaces shall be thoroughly cleaned prior to assembly and fixing. Each bond conductor shall be fitted with an approved metal label stating "ELECTRICAL BOND - DO NOT REMOVE". Where the thermal insulation is vapour sealed the sealing shall be

continued around the bonding lug where it passes through the thermal insulation. The main earth lead to each pipework system shall be provided and installed as part of the Electrical Services Installation Scope of Works.

For buried pipework systems the Contractor shall confirm builders work requirements for trenching, bedding material and back-filling as recommended by the pipework supplier for the application and the ground conditions appertaining. All buried pipework systems shall be tested and offered for inspection prior to back-filling.

To assist in the identification and tracing of all 'buried' non-metallic pipework systems, pipeline marker tape incorporating a metallic element and with suitable wording and approved colour to identify the service - blue for water and yellow for gas shall be laid above the respective pipeline. System dead legs shall be eliminated.

Easily removable sections of pipework shall be provided at connections to pumps, boilers and elsewhere as defined in BSRIA AG1/2001 to facilitate internal inspection of the equipment.

Where the use of plastic pipework and fittings are proposed the Contractor shall verify and confirm in writing that the pipework system will achieve the system operating life requirements at the system operating temperatures and pressures.

Thermostatic Mixing Valves

The mechanical domestic sub-contractor shall allow for the supply and installation of thermostatic blending valves to be provided on all hot water taps on all wash hand basins to ensure that the water temp does not exceed 43 degrees celcius. Mechanical contractor shall ensure thermostatic mix valves are suitable for operation at low head pressure. Thermostatic wash hand basin mixing valve to be as detailed on the attached schedule with chrome finish plumbing kit, which includes non-return valves, complete with strainers & isolating valves.

Valve sizes to be generally as follows:-

1 WHB	- 15mm
Up to 3 WHB's	- 22mm
Up to 6 WHB's	- 28mm

Valves to be located centrally under each range of basins to minimise the length of any dead legs from outlets.

Note: - on completion of the installation each thermostatic mixing valve shall be tested & commissioned by the manufacturer's representative. Once this has been completed a test certificate shall be issued by the manufacturer's representative for inclusion within the operation and maintenance manual.

DHW Electric Water Heaters

The contractor shall include for the supply and installation of unvented electric water heaters to provide the hot water services. The electric water heaters shall be appropriately sized to meet the usage profile. The water heater shall store water above 60°C and dispense water at safe handwashing temperature, and shall be

equipped with a TMV3 accessory pack to control the outlet temperature. All electric water heaters shall be timeclock controlled.

Water Meters (N/A)

Water Treatment Installations (N/A)

Water Treatment Systems (N/A)

Run of Piping

Although the run of piping is shown as accurately as possible on the drawings the contractor shall be responsible for arranging such runs both vertical and horizontal so as to avoid unsightliness. Where such arrangements involve special fittings or settings of piping even though not shown on drawing such fittings shall be provided under this contract. The contractor shall set out the run of his pipes and obtain the Engineers approval of their arrangements before fixing the pipes.

Disinfection of Plumbing Installation

On completion of the plumbing installation and before systems are allowed into operation the entire plumbing system shall be disinfected as follows: -

After disinfection the system shall be thoroughly flushed out.

It is essential that the dosed water does not remain in the system overnight and that the appropriate hazard warning signs and notices are conspicuously placed at taps during the disinfection process.

3.5 Element 54 – Gas Distribution Services

The contractor shall allow for the safe isolation, alteration and extension of the existing internal gas pipework serving the science classrooms.

Each individual teaching space that requires gas (Science) will have its own gas proving system with integral emergency knock out adjacent to the teaching wall with a second emergency gas knock out located elsewhere in the room. The pressure proving control unit shall be key operated only. Removal of the key shall isolate the gas services. Each individual gas proving unit shall control a gas solenoid slam shut valve located on the pipeline where the gas supply enters each area.

Installation, support, protection, pipework, joints and fittings must be in accordance with IS 820: 2000 and IS EN 1775: 2007.

All underground gas pipework shall be PE to GNI Regulations and internal above ground pipework to medium grade steel to BS 1387 and painted yellow. If CSST type pipework is to be used then proper electrical bonding is required. Steel pipework must have welded joints, except where flanges are necessary for connecting to valves, equipment, etc.

The contractor shall allow for all necessary changes and reconfiguration of gas pipework associated with the new gas tap configuration.

The contractor shall allow for the installation of a gas proving panel c/w lock and key configuration and emergency stop button in each classroom, incoming gas pipework to panel to be finished with a slam shut valve.

The gas supply serving the classrooms shall be isolated by a slam shut valve or automatically on operation of the fire alarm system or automatically on sensing of gas or carbon monoxide in the room.

The gas detection system shall have the facility to be re-calibrated for zero and span drift on site, and shall be supplied and installed by the mechanical contractor and commissioned in conjunction with the controls specialist.

Following a power failure, the slam shut valves shall automatically reopen when power is restored.

3.5.1 Gas Proving System (Science Pedestals)

The Contractor shall include for the supply and installation of a gas supply isolating and pressure drop testing system in each of the Science Rooms.

Each system shall consist of the following:

- Electrical control panel comprising key switch, emergency knock-out button and indicator lights to comply with IS 813.
- Gas pipe isolating unit comprising electrically operated safety shut off gas valve, by-pass test valve and pressure sensing device complete with pre-wired terminal block for connecting to the control panel.

The complete system shall be as manufactured by an approved manufacturer and shall consist Control unit / actuator unit.

Each individual teaching space supplied with gas shall be fitted with its own pressure proving system complete with integral emergency gas knock out adjacent to the teaching position with a second emergency gas knockout located elsewhere in the room. The pressure proving control unit shall be key operated only. Removal of the key shall isolate the gas services. The test mode operation shall operate via the key system and shall not require the operator to maintain pressure on a test button. The maximum test time of each system shall be 35 seconds. If a preparation room is shared between two Science rooms it shall be fitted with its own gas pressure proving system, if it is a dedicated prep room to only one Science room it shall be supplied from that Science room pressure proving system. All positions of valves, control units and emergency shut off buttons to be indicated on drawings.

3.5.2 Gas Outlets

The Contractor shall include for the installation of new spring-loaded gas taps within the Science Rooms.

These fittings shall be suitable for operation with 'Propane' liquefied petroleum gas and equal in all respects to the Marklab Spring loaded lever operated gas cocks suitable for bench mounting. In the closed position the lever shall be held in a position that it cannot be opened without being raised.

Gas cocks shall be colour coded to DIN 12920 for Propane.

3.5.3 LPG Control Valves

Gas solenoid valves shall be provided under this contract and shall be compatible with the control panels.

Immediately the gas service enters the classroom from the primary pipework a solenoid gas valve shall be provided and fitted. This valve shall be provided with a wall mounted control panel providing a gas testing facility to the internal gas pipework from entry to the room solenoid valve. This control panel shall be located within the main classroom and shall be connected to the fire detection system. On completion of the gas services the control systems shall be commissioned by local representative, who shall provide a certificate of inspection and testing.

3.5.4 Sleeves & Plates

Where pipes pass through walls or floors they shall be fitted with a sleeve at least one size larger than the associated pipe.

Each side of the sleeve shall be finished with a polished aluminium split pattern floor plate with a set screw to hold it in place.

3.5.5 Pipe Supports

Pipework above floor level shall be supported at 1000mm centres on s.b. pattern brackets screwed to structure.

3.5.6 Valves

Provide and install on the new gas and water supply pipes at the doorway into each room, a ¼ turn 'Fire Safe' pattern isolating valve to BS5351 complete with operating lever. These valves shall be lockable in the 'Closed' position and shall be complete with locks.

All branches rising to gas taps shall be fitted with a Fig 24836C3 Ballofix valve and branches to water standards with a Fig 23381 B1 valve. Valves shall be produced from Enkotal alloy.

3.5.7 Internal Pipework

All pipes shall be so supported as to prevent sagging and shall be laid and fixed, As to avoid the formation of pockets where moisture due to condensation can collect and lock the pipe.

All pipes shall so far as is possible be installed in such situations that they are accessible for the purposes of maintenance.

All pipework shall be black medium quality mild steel tube to BS 1387.

Fittings on pipework up to and including 50 mm shall be of best quality malleable iron to BS143 and 1256 banded or beaded pattern with screwed threads to BS21.

Fittings on pipework 65 mm and over shall be mild steel seamless welding type to BS EN 10253:Part 1, medium quality.

Union couplings shall be hexagonal black malleable iron spherical seat straight type three piece unions with female screwed ends to BS 21 and bronze to bronze seats as GF Fig. No. 342A or equal and approved.

Where space limitation prohibit the use of straight unions for the purposes of installation and maintenance, elbow and tee unions may be employed.

Reducers fitted on horizontal runs shall be eccentric and concentric on vertical as GF Fig. Nos. 260 and 240 respectively.

Underground pipework shall be PE.

3.5.8 Connection to Equipment

These shall be provided and fitted to the burners on the various items of equipment. This work shall include the supply and installation of isolating valves, regulators, pressure gauges, gas meters and armoured flexible pipe connections to the gas burners as detailed on the drawings.

3.5.9 Painting

All pipework and fittings at high level in the building and at the gas tanks shall be wire brushed, thoroughly cleaned and painted one undercoat and two gloss coats yellow Ochre BS 4800 colour reference O8C35.

3.5.10 Pipe Identification

At 3.0m centres on the horizontal pipelines and on the vertical drop to each item of plant a 300mm long length of piping shall be painted Yellow BS4800 colour reference O8E51 on which shall be stencilled "Propane Gas" in black with an arrow indicating the directions of flow.

A plastic yellow warning tape labelled "Propane Gas" shall be laid over the pipework in the external trench before it is backfilled.

3.5.11 Testing

On completion of the installation the gas pipelines shall be tested to twice the working pressure of the installation. This pressure shall be held air tight for at least four hours during which a "soap and bubbles" test shall be applied to all joints. Duplicate certificates of the test shall be provided for the Engineer.

3.6 Element 56 – Space Heating Services

The existing LTHW pipework and radiators shall be isolated, drained down and removed to suit the new teaching layout. Radiators shall be located, generally as shown on the drawing. The contractor shall check and verify space requirements prior to install to ensure no clashes with fitted furniture or other obstacles.

Generally, the space heating system shall consist of LTHW distribution pipework, insulation, brackets and supports, radiators and associated controls.

The heating system shall be a Low-Pressure Hot Water (LPHW) “two pipe” system with a typical flow and return temperatures of 60°C / 50°C using mild steel pipework to BS EN 10255:2004 (EN 10255). Heat emitters in classrooms, toilets, etc. shall generally be low water content radiators. These shall be fixed on external walls where possible below windows or in areas of maximum heat loss or as indicated on the drawings. The pipework and radiators are sized to accommodate future connection to a heat pump heating solution.

The teaching spaces shall be provided with an adjustable room sensor controlling a motorised 2-port control valve. The valves are to be locally wired and a power to open, power to close type actuator shall ensure that when there is not any heat demand required the valve does not sit in standby and draw unnecessary energy use.

All pipework located in corridors and areas where heat loss from pipework is NOT demonstrated as ‘always useful’ is to be insulated.

All valves of 65mmø and above, and flanges, shall be insulated by boxes fabricated from 0.7mm thick hammer-clad aluminium sheet, lined internally with the same insulating material as that of the pipeline and to suit the unit to be enclosed.

The box shall be in two sections hinged together at one side and fastened with neat proprietary fasteners at the other. The box shall be designed and made in such a manner that the insulation is of a minimum thickness equal to that of the adjacent pipeline, the insulation fits tightly against the unit to leave no gaps, the box is easily removed and replaced, and the operation of any valve remains unimpaired with the box in place.

All valves and flanges below 65mmø shall be insulated by removable flexible muff covers comprised of mineral wool insulation encapsulated in a pvc or silicone coated glass fabric jacket and secured by means of velcro pads and nylon draw strings.

3.6.1 Radiators

Provide and fit low water content radiators as detailed on the attached schedule and be of suitable size and type to meet the requirements as detailed on the Radiator Schedule on the relevant drawing. Each radiator shall be complete with an isolating valve with hand wheel on the flow connection and lockshield valve on the return connection and concealed headers.

Radiators in circulation spaces shall be fitted with lockshield valves only and not adjustable TRVs. These radiators shall also be controlled with 2-port valves linked to temperature sensors.

Each radiator shall be provided with flow and return radiator valves, a recessed key operated air vent and screw-to-wall brackets.

Bracket shall be fixed to walls with 65mm long NO 12 brass screws using plastic type plugs.

The radiators shall be given a primer paint finish before dispatch from works and shall be complete with all necessary screw to wall brackets, fixings etc.

The mechanical contractor shall allow for removing the radiators to facilitate painting and for re-hanging afterwards.

Prior to placing an order the contractor shall visit site and carefully examine the drawing to ensure compatibility of the radiator with respect to sill heights room layout/space and connections to each radiator.

3.6.2 Radiators Valves

Each radiator and pipe coil shall be provided with an angle or straight valve on the flow inlet of the size detailed in the radiator or coil schedule and an angle or straight pattern closed lockshield valve on the return outlet.

Closed lockshield radiator valves shall be in bronze to BS 2767 with C.P. finish as manufactured by Crane Ltd., Fig D 881CP or D 891CP or equal to approval. Provide and leave on site 4No. P101 keys for removal of the security screw of the lockshield cover. The double regulating feature for angle lockshield valves shall be set at the system commissioning.

Wheel-head valves shall be in bronze to BS 2767 with a C.P. finish as Crane Fig D 880 CP or D 890 CP or equal and approved.

All radiator valves shall be of the union type with the inlet thread to BS 21 and a polycarbonate hand wheel or lockshield cover.

A thermostatic valve with a C.P. finish shall be fitted to the flow inlet of radiators indicated on the drawings as TRV. These shall be the Danfoss 'N' series with a tamper-proof setting for use on a one-pipe circuit and they shall be installed and connected to the top flow inlet of the radiator with the temperature sensing element in line with the radiator. Thermostatic radiator valves shall be provided with a lockable temperature setting facility.

3.6.3 Pipework & Fittings

All LPHW pipework within the plantroom shall be generally in accordance with BS EN 10255:2004 and as detailed within the general specification section of this document.

The distribution of the heating pipework will generally run in the ceiling space where possible.

3.6.4 Pipeline Support System

All pipework shall be supported generally in accordance with BS 3974 and as detailed within the general specification section of this document.

3.6.5 Automatic Air Vents

Automatic air vents shall be provided on all high points in the system whether indicated or not. Each air vent shall be fitted with a lockshield isolating valve and 10 mm table X copper pipe to BS EN 1057:1996, to drain outside.

3.6.6 Draincocks

15mm gunmetal, lever operated, gland type drain cock, with a hose union outlet as B.S.S. Ltd Fig 81HU.

Note: Draincocks to be fitted at all low points.

3.6.7 Commissioning Sets

Commissioning sets shall be installed and located at appropriate points to provide circuit balancing. Commissioning sets shall comprise a regulating valve with integral or direct coupled orifice plate to provide the fluid flow regulation and measuring facility respectively.

3.6.8 Expansion & Contraction

The contractor shall be fully responsible for making provision within the detailed pipework design to accommodate differential expansion between the pipework, other connected services and the building structure. Allowance for expansion should be provided on all pipework with straight runs greater than 25meters.

3.7 Element 57 – Ventilation Services

3.7.1 General

A fume cupboard located in science room prep rooms shall have mechanical extract provided under the mechanical contract. Make up air will be achieved via openable windows.

An exhaust & supply fan shall be provided for the chemical store under the mechanical contract. These shall be interlinked and set to operate via a timeclock once every 8 hours for 30minutes as detailed on the drawings.

A CO₂ monitor with LCD display (Size 8.5cm²) within each science room shall be provided. LCD to be c/w 3 colours (green, amber & red).

CO₂ monitor shall be as a wall mounted sensor range.

CO₂ monitor shall be set as follows:

Carbon Dioxide Traffic Light Display Indicator Ranges		
Green	Amber	Red
<1000ppm	1000 to 1500ppm	>1500ppm

3.7.2 Ductwork

Components for sheet metal ductwork shall be manufactured to a high standard of construction and finish, generally to comply with the Specification for Sheet Metal Ductwork, DW/144, as published by the Heating and Ventilating Contractors' Association (HVCA).

All ductwork serving fume hoods must be PVC (for mild corrosives) c/w fully welded or sealed joints, connecting to corrosion resistant centrifugal exhaust fans.

Access Openings in Ductwork

Access covers and doors in ductwork which is insulated or acoustically treated shall be similarly treated to achieve the same standard in service as the complete ductwork system.

Access doors and covers on negative pressure systems shall, wherever possible, be hinged to open outwards and be secured by cam-lock fasteners. Access doors and covers on positive pressure systems shall be completely removable and shall seat into a frame such that the air pressure will assist closing. They shall be secured by centre screw hand wheel and channel section clamping bar. When the door is closed no part of it shall intrude into the duct section or reduce the duct cross-sectional area.

Hand holes shall be 100 mm. minimum diameter with cover plate, dished, manufactured from metal 0.4 mm. thicker than the duct material, the cover plate being secured by means of a cross bar and screw. Hand holes shall be provided adjacent to any thermostat or similar instrument fitted into the duct. Gaskets shall be fitted to all cover plates.

Tapping and test holes shall be provided with a suitable airtight cover or plug. Test holes shall be provided in accordance with C.I.B.S.E. Commissioning Codes, Series A, Air Distribution.

Ductwork, both circular and rectangular, high velocity and low velocity shall be supported in accordance with the HVCA Specification DW/144.

All ductwork shall be adequately supported, stiffened and braced to prevent sagging, "bellling", and drumming under operating conditions, with additional supports being used for less rigid components.

For circular and flat oval ductwork, two piece rings shall be used, manufactured from mild steel to closely fit the duct circumference and shall be complete with bolts, nuts, washers and spacing pieces. Rings for ductwork having thermal insulation with vapour barrier applied shall be enlarged to take a liner of the same thickness as the applied insulation.

Screwed studding shall be manufactured from mild steel to comply with BS.4439, and nuts and locknuts shall be used when coupling under-duct angle supports to studding drop rods.

When fixing to structural steelwork, clamp-on brackets of the "Lindapter" pattern shall be used, installed in the manner recommended by the Manufacturer. Holes shall not be cut in structural steelwork for supports, nor may the supports be welded on.

Supports shall not be fixed directly to ductwork or equipment unless, in the case of equipment only, special support lugs are incorporated by the Manufacturer.

Studding sling bolts, and steel screws, bolts, nuts and washers, shall be sheradised. All other steel components shall be free from rust and scale and finished with a substantial coat of zinc-rich paint before delivery to the works.

Felt, strip rubber or similar materials, approved by the Engineer, shall be inserted between supports and ductwork to minimise vibration transmission.

Hardwood or similar material, approved by the Engineer, shall be inserted between supports and ductwork having thermal insulation with vapour barrier applied.

Flexible Joints in Ductwork

Flexible joints in ductwork shall comply with HVCA Specification DW/144 and shall consist of, or be protected by, material capable of attaining Class 1 flamespread in accordance with BS.476: Part 7. The material shall be of the glass fibre cloth type: canvas shall not be accepted.

Flexible joints shall be provided on fan inlet and outlet connections and elsewhere on the ductwork where indicated. They shall be of the full cross-sectional area of the mating fan inlet or outlet duct section.

Flexible joints shall be kept as short as practicable, above a minimum length of 50 mm. and in no case shall a flexible joint exceed 250 mm. in length.

Where flexible joints are connected to fans, etc., the fans and equipment shall be isolated from metallic contact with ductwork such that a clear gap exists between the ends of the ductwork and the equipment. At these points, the ducts shall be supported close to the gap so as to remain lined up under all circumstances.

On rectangular connections, the material shall be held in place by a mating flange with a backing plate. If proprietary material is used, the metal edge shall be held in position by a backing plate of no less than 3 mm. thick. A sealant or gasket of the liquid/mastic type shall be used, which shall permanently retain adhesion and elasticity throughout a temperature range of 0 degrees C. to 70 degrees C. The gasket shall not be less than 3 mm. thick for ductwork up to and including 1 mm. sheet thickness, or less than 4 mm. thick for ductwork above 1 mm. sheet thickness. Prior to application of the sealant, all surfaces shall be thoroughly cleaned and shall provide an airtight joint.

On circular and spirally wound ductwork a coupling shall be attached to the duct end to provide a smooth surface and the ends carefully cleaned with a suitable solvent

over the length of 100 mm. minimum. A similar sealant to that stated above shall be applied and the joint secured by clip bands with adjustable screw and toggle fittings.

Flexible Ductwork

Where flexible ductwork is indicated or required between rigid ductwork and particular components or items of equipment, the internal diameter of the rigid ductwork and of the spigot served shall be equal. The use of flexible duct between rigid sections of sheet metal ductwork to change direction or plane shall not be permitted, except where indicated or expressly authorised by the Engineer. Bends or offsets in flexible ducting shall be of the slow type and the minimum of ducting required between two fixtures shall be installed in all instances.

Flexible ducting shall be fabricated from material capable of retaining Class 1 flamespread in accordance with BS.476: Part 7. The flexible duct shall have a liner and a cover of tough tear resistant fabric equal in durability and flexibility to glass fibre fabric. It shall be reinforced with a bonded galvanised spring steel wire Helix between the liner and the cover and an outer Helix of glass fibre cord shall be bonded to the cover to ensure regular convolutions.

Flexible joints shall comply with HVCA Specification DW/144. The joints to rigid spigots shall be sealed with a brush coat of mastic compound and secured by clip-bands with adjustable screws and toggle fittings.

The frictional resistance to air flow per unit length of flexible duct shall not exceed 50% more than the frictional resistance per unit length of galvanised steel ducts of equivalent diameter.

The leakage from any section of flexible duct shall not exceed 1% of the design air flow rate at the static operating pressure.

Identification of Ductwork

Ductwork installations shall be identified in accordance with the recommendations of Appendix C of the Specification for Sheet Metal Ductwork, DW/144, as published by the Heating and Ventilating Contractors' Association (HVCA).

Identification symbols shall be located in positions where they are easily seen and at sufficient frequency to avoid the need for ducts to be traced back. Symbols should be at maximum six metres spacings and shall be provided at all changes in direction in the ductwork system.

Colour coding of ductwork identification symbols shall be in accordance with Table 33 of DW/144 or as otherwise directed by the Engineers.

Direction of airflow shall be indicated by the symbol being an equilateral triangle with one apex pointing in the direction of air flow.

On Contracts which have large complex installations with many zones, widely branched distribution systems or several plants further identification shall be provided in the form of numbers or letters to a coding to be agreed with the Engineers.

An explanatory chart explaining the colour coding and figure or letter coding, where appropriate, shall be provided by the Contractor for inclusion in the Operation and Maintenance Manual.

Volume Control Dampers (Manual)

Manual volume control dampers shall be manufactured by one of the scheduled firms and be of the size and type as detailed in the schedule or drawings.

Dampers shall comply with HVCA Specification DW/144 for air systems. Dampers shall be of the multi-leaf stainless steel opposed blade type enclosed in an airtight casing complete with ductwork connection spigots. All dampers shall have clearly marked open and closed positions.

Each damper shall have die cast zinc alloy gears mounted within the casing, but completely out with the airstreams. The damper control lever shall have the provision for marking the setting after commissioning and be capable of being locked in position. Dampers shall be provided as shown on the drawings and when required samples of the type proposed shall be submitted to the Engineer for approval before ordering. Removable panels incorporating purpose made air seals shall be located adjacent to all dampers.

3.7.4 Fans and Accessories

Each new fume cupboard is to be installed with centrifugal explosion proof extract fan continued with back draught shutter, sound attenuator, exterior wall mounting bracket and a motor weather cover.

Chemical store rooms are to be fitted with low level extract fan and high level supply fan to allow for removal of harmful chemicals present in the air.

3.7.5 Air Terminals, Grilles and Louvres

Note: - any air termination devices noted in the following paragraphs are deemed to meet the standard required for the project, any other air termination devices of a similar standard and specification will also be deemed to be acceptable.

These shall be as manufactured by Gilberts (Blackpool) Ltd, or equal and approved and of the sizes, types and handling the air volume as detailed later in the schedules at the end of this specification. Each supply and exhaust grille shall be fabricated in aluminium with a stove enamelled silver finish or colour finish as selected by the Engineer.

All supply and exhaust grilles shall be complete with a purpose made grille box to suit the grille dimensions and with a suitably sized circular or rectangular spigot piece to connect to the main ducting.

Each supply and extract grille shall be supplied and fitted with a multi-blade volume control damper fitted by the manufacturers.

3.8 Provision of Co-ordinated Services Working Drawings by Mechanical Contractor

The mechanical services contractor shall provide full and detailed co-ordinated working services drawings which are to be undertaken in conjunction with the electrical services contractor and main contractor in order to ensure a co-ordinated approach to services distribution ensues throughout the school building and through all spaces, taking into account the building fabric, structure and building services intent shown on the Ipsum drawings.

The mechanical contractor shall take the lead in the production of the drawings for approval with the electrical contractor assisting and inputting with their own working drawings and these shall not be limited to:

- 1:50 scale GA drawings showing routing and plan throughout new proposed building
- 1:20 scale sections demonstrating integration with the structure and fabric particularly at any pinchpoints.
- 1:50 scale reflected ceiling plans with services shown including lighting.
- Demonstrate confirmation of co-ordination of services on internal elevations

3.9 Commissioning of Systems

The Mechanical contractor shall include for the complete testing and commissioning of the installations which must be to the complete satisfaction of the Architect/Engineer.

The mechanical contractor shall arrange for the commissioning of the installations to be carried out by a firm of suitably qualified independent commissioning engineers. Full details of the proposed firm must be submitted to the Engineers office prior to the works commencing.

All testing and commissioning shall be in accordance with the recommendations as detailed in the relevant Chartered Institution of Building Services Engineers Commissioning Codes and/or BSRIA guidance documents.

The proving of the engineering systems from the "static" completion stage to a fully operating one shall be carried out by the independent commissioning engineer.

The proving of the systems shall include all the system balancing and recording of test data and set points, together with the setting of the environmental conditions and recording test data against external conditions.

The contractor shall refer and comply with all details outlined in section 4.1.171 through to 4.1.248 relating to the commissioning and handover of the installed mechanical systems.

As outlined in both CIBSE and BSRIA commissioning codes, the recommended tolerance for main heating flowrates is typically within 0 to +10% of the design value.

If flow rates lower than those expected based on the specified tolerances above are observed, the contractor shall thoroughly investigate the condition to determine the underlying cause. Where practicable, appropriate corrective measures should be implemented to bring the system within the recommended tolerance values.

Table WA1.1 Suggested tolerances for flow regulation in heating systems

Component	Tolerance
Natural convectors (e.g. trench heaters, radiators, and radiant panels)	Return temperatures all within $\pm 3^{\circ}\text{C}$
Forced convection (fan driven) heating coils where flow rate is $< 0.015\text{ l/s}$	Refer to section WA1.4.1
Forced convection (fan driven) heating coils where flow rate is $\geq 0.015\text{ l/s}$ and $< 0.1\text{ l/s}$:	
Heating water $\Delta T \leq 11^{\circ}\text{C}$	$\pm 15\%$
Heating water $\Delta T > 11^{\circ}\text{C}$	$\pm 10\%$
Forced convection (fan driven) heating coils where flow rate is $\geq 0.1\text{ l/s}$:	
Heating water $\Delta T \leq 11^{\circ}\text{C}$	$\pm 10\%$
Heating water $\Delta T > 11^{\circ}\text{C}$	$\pm 7.5\%$
Branches:	
Heating water $\Delta T \leq 11^{\circ}\text{C}$	$\pm 10\%$
Heating water $\Delta T > 11^{\circ}\text{C}$	$\pm 7.5\%$
Mains (flow from pump)	0 to $+10\%$